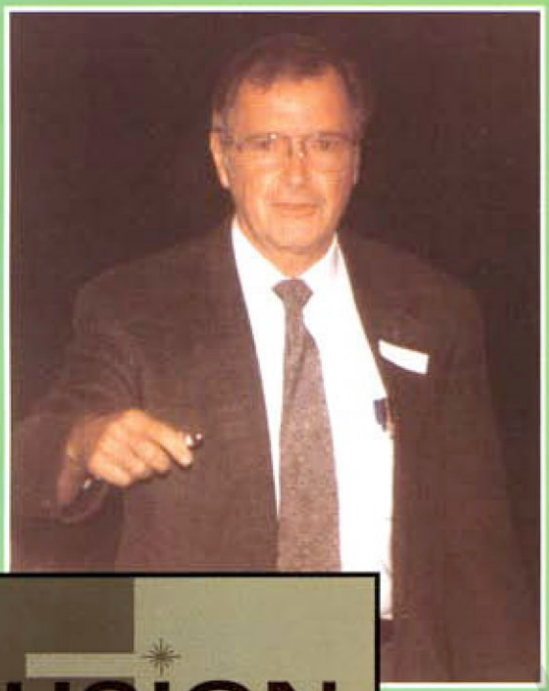
Infinite Energy

Cold Fusion and New Energy Technology

Published by Cold Fusion Technology Vol.2, No.9, 1996

Professor George Miley— *Fusion Technology* Editor Confirms Low Energy Transmutations



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Infinite Energy

Cold Fusion and New Energy Technology

Volume 2, No.9, July/August 1996

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INFINITE ENERGY Magazine *(ISSN 1081-6372) is published six times a year by Cold Fusion Technology, P.O. Box 2816, Concord, New Hampshire 03302-2816. Subscription price: $29.95 U.S. and Canada, $49.95 other foreign. POSTMASTER: Send address changes to INFINITE ENERGY, P.O. Box 2816, Concord, NH 03302-2816.*

INFINITE ENERGY Magazine
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Concord, NH 03302-2816
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PRINTED IN THE USA

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Professor George Miley (Nuclear Engineering, Univ. of Illinois) confirms that low-energy nuclear reactions—heavy element transmutations—occur in cold fusion cells. ***(Courtesy, Dr. G.Lin)***

Carbon arc struck under ordinary water produces unusual gas— "AquaFuel." But is it "over unity"? ***(Courtesy, Rob Jaeger)***

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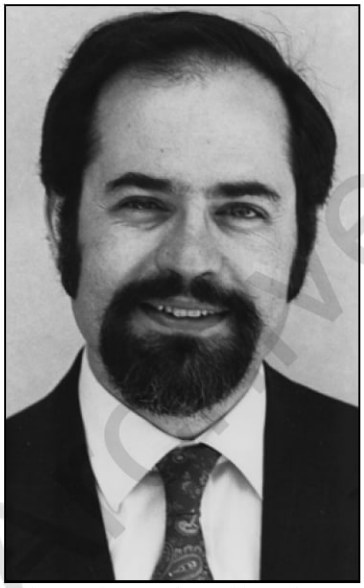
By Eugene F. Mallove, Sc.D.



"SuperPower, Inc."

Since that strange afternoon announcement in Utah on March 23, 1989 life has become almost overwhelmingly exciting, but also exceedingly tough on pocketbook and home! Yes, money isn't everything, but it sure helps us carry out investigations of strange machines and it puts frontier research magazines in your mailboxes.

We could get rich these days if we had only a dollar for every request for information on the "best investment *right now* in cold fusion and new energy." We'd love to be able to tell people, "Call up company 'XYZ' and they'll welcome you with open arms if you have $1,000, $5,000 or $10,000 to invest." Sadly, such opportunities do not *yet* exist. Many, many small investors are willing to put up money for cold fusion and new energy, but there is no place for that money.

While bemoaning that so little investment capital has flowed into cold fusion and new energy R&D in the U.S., we came up with an idea whose time has certainly come. "SuperPower, Inc." (or call it what you will) — a kind of "mutual fund" for cold fusion and new energy technology, a capital pool for investing in a range of such technologies.

The idea for such a fund would be to spread the investment risk over a range of companies and processes into which investment capital from the fund would flow. For this fund to achieve significant early stage status in a range of key technologies, the target magnitude of the investment pool should be $20 million to $50 million. To aid the field and our continued information dissemination efforts, the publishing company of this magazine, Cold Fusion Technology, intends to *help* launch such a fund. We have no financial or legal expertise in such matters, so we have called on those who do have it.

If such a capital pool could be launched, what would *we* get out of it? Lots more to write about, for one thing! We would also get sustaining funding for operations at our new 1,800 square foot publishing facility and laboratory at the Bow Technologies Center. Of course, we and our consultants would also like to receive a minor equity position in the fund in addition to paid consulting services. Let's see, one percent of a trillion dollars is...?

There is a great temptation to try to begin from scratch to evaluate the cold fusion and new energy opportunities. That will not work! This field requires the kind of advisory expertise and experience that people like ourselves, Hal Fox, and others in the field have built up over the years.

Furthermore, new and potentially better opportunities are arising quite frequently as the pace of our science and technology quickens. Due to our information gathering and distribution activities, we can act as an "early warning system." We have just about the best chance of identifying new opportunities in cold fusion and new energy before anyone else hears about them.

Anyone today who picks a *single* investment opportunity in cold fusion and new energy and tries to invest in that company will at this stage run a high risk. There needs to be *shared risk* among companies and among investors in a capital pool. For individual investors, the capital pool concept is, in our view, the only reasonably safe approach to investing in this field. At this stage, it is far from certain which horse or horses will win this technology commercialization race. When the fund to be formed is eventually traded publicly, there will be a rush to invest in that fund by those now unable to afford the hundreds of thousands or several millions of dollars needed right now.

In May 1991 when I completed *Fire from Ice*, I concluded that the evidence for the reality of nuclear-scale excess energy and nuclear products in "cold fusion" was "overwhelmingly compelling." Now there is 100% certainty that we are dealing with a civilization-changing technology that will revolutionize the entire energy sector. We recently held a briefing in Cambridge, Massachusetts to substantiate that claim before several assembled potential "SuperPower, Inc." investors and we received valuable feedback and some interest in moving forward. Give us some time. We don't give up easily—not on an idea *this* important.

Avid readers of *Infinite Energy* know that something even more remarkable than the confirmation of the original 1989 claims by Drs. Pons and Fleischmann has already occurred. Every year since then, the field has yielded new findings and potential technologies that make this energy easier to obtain. For example, we now have several U.S. corporations working on systems that do not require the heavy water/palladium system pioneered by Drs. Pons and Fleischmann. They use ordinary water and nickel electrodes. There are now several groups that do not even employ liquid electrolysis, but rather ordinary hydrogen gas in contact with special substrates that produce very high temperatures—hundreds of degrees C, making the process much more suitable to near-term production of electricity.

Further-more, the power densities have gone up considerably. It is now clear that 1-10 kilowatts per cubic centimeter of substrate have been demonstrated by numerous groups. Prototype experiments that produce over one-kilowatt of thermal power have also been accomplished. At least one company with which we are familiar—HydroCatalysis Power Corporation— says it has a clear shot at producing a one-kilowatt electric generator within the next 18 months, based on these elevated temperatures and power densities. So fast moving is the field, however, that someone else could easily scoop them. We keep telling our colleagues at work in the various R&D companies: *there is a major premium for being first across the line.* As

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we went to press we heard of two firms that will soon introduce demonstration unit cold fusion cells that you will be able to buy. We *hope* there will be an ad in IE #10 for those cells.

As though the above is not tempting enough for potential investors to consider, we have the astounding development in parallel—incredible even to confirmed cold fusion pioneers like us—of patented electric gas discharge processes and exotic magnetic motors that produce more electrical or mechanical energy out than input electrical power. That there will be self-sustaining electrical generators is now nearly certain, based on our most recent investigations. Fortunately, there are some excellent theoretical formulations, published in peer-reviewed physics journals, that make this seemingly impossible technology believable; this has to do with the tapping of so-called Zero Point Energy of quantum vacuum fluctuations. Theories mean nothing, however, compared to the dramatic potential of the concrete data on these systems to begin to overturn the entire energy infrastructure, beginning in the next several years.

Last, but certainly not least of these excellent opportunities: irrefutable, replicated evidence has emerged in cold fusion experiments of the low energy transmutation of heavy elements. This means that looming on the technology horizon are both the remediation of nuclear waste (a near term multi-hundred billion-dollar industry) and, down the road, the possible low-energy production of precious metals.

We believe we are one of the most dynamic and well-informed groups in the world on all these technologies. We are ready to advise and help effect the disposition of investment resources into an appropriate mix. We recommend a balance of technologies that are near-term marketable (some of these ancillary items exist already) and ones that show promise of blossoming in three to five years.

In our view, there is a rapidly closing "window of opportunity" in this field. Seed money of perhaps $2 million would be necessary to launch the proposed investment initiative. As additional resources in the range $20 to $50 million were obtained, this investment group could become a driving force in the cold fusion/new energy technology revolution. The revolution is coming! May we all learn to *do very well by doing good* in promoting clean, infinite energy.

ICCF 6th. International Conference on Cold Fusion

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LETTERS TO THE EDITOR

I finished your book *Fire from Ice* while vacationing in Carmel, California. Great job!! The book was chock full of interesting people, events and technology all bundled in a marvelously cohesive fashion. Your writing style is easy to read and lively, which makes for a good read on a technical subject.

I've written to Paul Correa twice requesting more information. I believe he's at the stage of selling the rights to people for particular specific applications. I am awaiting a reply to my second inquiry.

I've been reading on the Internet about a fellow named Bruce Perrault (New Energy Horizons — Campton, NH), who is selling kits for a device which at first glance appears to be similar to Correas. Mr. Perrault says it's based on the radiant energy technology of Henry Moray from the 30's. It uses a high voltage to ionize a reactive gas (such as chlorine), which then reacts with the anode and cathode material to capture free electrons. His kit device develops approximately 0.2 kW and he's designing a 50 kW version similar to Henry Moray's long-destroyed device.

I really don't know what to think of all these over-unity devices. It would be terrific if they really worked, but if they really worked, a product should have reached the market by now. One would think that a large corporation would spend millions of dollars to develop a patentable device into a working energy generator. I haven't seen one yet.

The over-unity folks decry "conspiracy!" Perhaps the large corporations can't even conceive of the possibility of an over-unity generator and the little-guy inventors run out of their own R&D funds. What do you think?

Greg Glenn
Pacific Palisades, California

What I think is just what you suggested: "Perhaps the large corporations can't even conceive of the possibility of an over-unity generator and the little-guy inventors run out of their own R&D funds." That and "Inventor's Disease"—excessive secrecy and lack of understanding of marketing are seriously retarding the field. But rest assured, there will be winners—not everyone is inept! —EFM

•—•—•

I want to thank you for your prompt response in getting me caught up on my back issues of *Infinite Energy*. They arrived in time to take with me on my recent vacation.

I found the paper by Mizuno, Ohmori, and Enyo entitled "Anomalous Isotopic Distribution in Palladium Cathode after Electrolysis" to be a most encouraging and revealing report. [See *IE* #7] All I can say is a profound thank you for the service that you, Jed, and others are providing scientists and investors with prompt and informative reports on the breakthroughs that are occurring in Cold Fusion research. I believe that one of these days, after the dust has settled and the historians have had an opportunity to reflect upon the first ten years of Cold Fusion and related new energy research, they will recognize the pivotal role that was played by those of you who have provided us with *Infinite Energy* and similar publications.

Professor Robert Eagleton
Pomona, California

Thank you, Bob! And good luck with your *research. —EFM*

•—•—•

Our national Conference of Friends of the Earth starts on Friday [Sept.] 13th (!) and, as I said in the article, I have put forward the motion for debate. It has to go through a prioritisation ballot to see what order we debate the motions in because there will not be enough time for all of them. I shall be lobbying the delegates, as they arrive, to see if I can swing the result in our favour. Even if they do not give it sufficient votes, I have organised a "fringe" meeting for the evening session, and I will try to get the top people along. Your mag will be prominent!

I have taken the liberty of using part of Jed Rothwell's piece off your web page for my presentation (for published scientific evidence). What I would like to ask for is if you can send me any late breaking stories/results that I can amaze the audience with — if I can instill in them a feeling that there is a gathering wave of reliable evidence accumulating, not only for CF but also the Correa's tubes and particularly the magnetic motors of Kawai and Takahashi (which I see as the most useful new energy technology), then it will be much easier to get them to ratify the motion and the Board of FoE will have to take more notice. Although the energy and climate change section of FoE are now well aware of CF etc, their recently published report makes no mention of it — the memories of 1989 are probably still exercising an undue influence. Whatever happens I will keep you informed. — Nick

.....Three weeks later.....

Well, I went to the Friends of the Earth Conference and did my best to lobby people. I managed to convince most that I talked to that there was something worth investigating, but I only had a limited time before the prioritisation ballot. To cut a long story short, there were 23 motions put forward and we were given time to debate about 12 to 13. The result of the ballot was that the motion would have been number 18 so it didn't make it (however, see later!)

I said that I was going to hold a "fringe" meeting and 20 people turned up (out of 300 delegates — and there were 15 other fringe meetings). I managed to convince almost all that there was something really significant (even a very skeptical physicist who had discovered *IE*'s web page a couple of days ago —by accident). The audience seemed to feel that there may be unsuspected environmental effects that we don't know about yet — some mentioned the "too cheap to meter" stories from the birth of fission energy and the associated wild optimism.

As the conference was finishing, I managed to "accidentally" bump into the Director of British FoE. He said that he had read my motion and was interested because he had been starting to hear things recently and was keeping an eye

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out for news. He asked me to write to him with a review of what was new and "proved." He said that if it looked interesting, he would recommend passing it down to the campaign teams to evaluate, so it looks as if I might have found a "back door" way of influencing policy.

FoE's senior energy campaigner was rather more negative. I had sent him issue #7 of *IE*. He said that he had checked up with various people in the energy field and they all said that the evidence for CF et al was still hotly disputed (as we know) and that he couldn't find anyone who was impressed with it. He then said a rather strange thing — that even if it proved to be true, that he couldn't see that it would have much of a potential for altering the energy supply situation of the world.... hmmmm. He did say that he would like to see or ride the Takahashi Sciex scooter and, as FoE HQ is in London, I wonder if you could arrange something like a demonstration for him? or of any of the other things?

I gave him Chris Tinsley's phone number (for a more knowledgeable chat than I could give him), but I don't think he has used it yet. Without seeing any physical evidence myself, I have to say that I can't fully commit myself to believe in the devices (due mainly to the fringy Keely-net "pseudo-science" types that seem to be around them). I accept that you have seen them, but there is nothing like personally "feeling the heat" or charging one's own batteries to convince one. A commercially viable, mass manufactured device would do it nicely of course - you and Jed are perfectly right about that!

Nick Palmer
(Jersey FoE) England

We thank you, Nick, for your fine, comprehensive report. We wish all "Green" people were like you; sadly, they are not, as your report vividly shows. Yes, demonstrations are the sine-qua-non. We hope that in the next six months you'll have all the evidence you'll need. Just come to our lab, once the Hydrosonic Pump is set up, and we'll make you "feel the heat." We also expect that there will be commercially available excess heat CF cells in the next two months.—EFM

• — • — •

Firstly, a hearty congratulations on an excellent magazine! I'm not involved in the science world, but I have always been an enthusiast, and so I have strong memories of 1989 when to my considerable surprise and delight the great announcement was made! Then as we all know it kind of went off the rails a wee bit ...I had never forgotten the weeks around that event, and so I was most pleasantly surprised to find that years later the research was still going on, and in fact we were not far from having useable CF power of some sort in the everyday home. Ok, I'm still waiting, but I now know that when I'm old (only 31 years now) & gray I won't have to be worrying about how much oil there is left to suck out of the ground. I guess my father is a good example of the "oil power" generation. When I try to bring up the subject of alternative power sources for the next 100 years or so, he usually comes back with, "You'll always have oil, even when you're older than me." (He's 66.) Up until recently, I could only reply, "Well, *you* won't have to worry about it, but *I* will!" He then wittily responds with a grunt ...

That's all changed after letting him have a read of *Infinite Energy*! It's like he's been, well, enlightened! I couldn't believe it. The other day he actually asked me what I thought the chances were of life on other planets. (After the "Mars rock" news) I did the usual trick by asking him what he thought the odds were that there *was* something out there. Say, one in a billion? He thought that was about right, then I explained that there are about 100 billion stars in our galaxy, and so far we've detected over 130 billion galaxies ... Hmmm ... no grunt! There's hope yet for the "oil power" generation.

Anyway to the point —I wish to purchase 5 Cold Fusion stickers.

Oh, one other thing. I'm also a budding science fiction writer, and I'm having a bit of trouble at the moment. I prefer to make the story have some basis on realistic physics, but it's a tad difficult to do when the blasted rules keep changing! It used to be so easy. There were protons & electrons & quarks & plasma fusion reactors and so on, but now we have Zero Point Energy and *ten* dimensions of space. Look, I *really* don't mind you pulling the proverbial "rabbit out of the hat," but do you have to drag the rabbit's whole family & friends as well?? ;) I await the new energy future with open arms— and the future is exquisitely bright!

Em tasol, wantok,

William H. D. Sherwood
Chipping Norton, Australia

Glad always to hear good tidings from our many "down under" subscribers. Sorry, Bill, many, many cute little rabbits will be pulled out of their holes in the coming years. AND, many troublesome skunks (read: paradigm police) will be squashed flat on the road. I sure hope "Em tasol, wantok" is O.K. for polite company!—EFM

• — • — •

Your putting an article on water based fuel in your magazine was and is greatly appreciated [See *IE* #5&6, p.61 on Gunnerman's A-55 fuel.]. It is a subject that strikes close to home; especially with rising fuel prices and the possibility of a fuel crisis. I am renewing with the hope that I will find more about this fuel, i.e. how available is heavy naptha? How safe is it? Can individuals mix their own water-based fuel, etc.?

Edward Nolan
Newark, California

The 55% water-based fuel of Gunnerman is now being sold in the state of Nevada. We will have future coverage of the commercial developments of this fuel.—EFM

• — • — •

Please update the address for my subscription to *Infinite Energy*. Also, I would like to order issues #1 through #4. I purchased issues #5/#6 and #7 on a newsstand. I look forward to reading more of your wonderfully optimistic publication.

Bill R. Eubanks
Athens, Alabama

• — • — •

A subscriber sent us a copy of his letter to a former U.S. Senator, who is now in a key environmental position:

Gaylord Nelson
Wilderness Society
900 17th St.N.W.
Washington, D.C. 20006

Dear Gaylord:

I hope all is well with you as we come down the stretch of our latest political funny season. I am very much engaged in continuing research on new energy sources, and as I come upon new information I believe might interest you I will be sending you letters such as this one. One of the most astounding stories — a scandal, really — I've uncovered is the continuing efforts of two government agencies -- the Department of Energy and the U.S. Patent Office —to hinder and even sabotage development of new energy sources that threaten to replace fossil fuels and nuclear power. The best source for information on this sad tale is Dr. Eugene Mallove, the editor of *Infinite Energy*, one of the best sources of information concerning cold fusion and other new energy approaches. I have asked him to prepare the enclosed briefing for you on the exciting developments relating to research and development of cold fusion and other non-traditional renewable energy sources. Please give this your closest attention, as it should provide you with additional and very powerful evidence of the reality of the energy revolution I've been discussing with you.

.....

I can safely predict that some company or companies will soon be producing and delivering extraordinary new energy technology to American consumers. Whether or not American companies will be the first to commercialize successfully these new technologies is a very open question, how-

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ever, as the Japanese are way ahead of us in the volume, scope, and speed of their investment in 21st century energy technology.

As the Middle East heats up once again, there is no more urgent topic than the one I am bringing to your attention. I hope you will come to understand this very soon.

Dr. Mallove stands ready to provide you and others in the environmental movement a personal briefing on these matters. Other experts such as Dr. Brian O'Leary and Hal Fox of *New Energy News* are also ready to do the same.

By the way, have you had a chance to read Brian O'Leary's book, which I sent to you not long ago? Please let me know if you have any questions. I will do my best to get them answered.

Your persistent former aide,

Stephen Kaplan
Portland, Oregon

• — • — •

I have been reading and re-reading issues #7 and #8 for weeks now with great fascination. They are both power packed issues and I think issue #7 may be a "dam breaker." Confirmations by NASA, Los Alamos, Japan, the Correas, and interest from the environmental community (a long time coming), are all major breakthroughs that cannot be ignored. I had a vision recently that I walked into a book store and *Infinite Energy* was next to *Scientific American* on the magazine shelf. *Scientific American* and others such as *Discover* were also filled with new articles on cold fusion.

Chuck Bennett
Sacramento, California

Nice fantasy, Chuck! However, in reality, the only articles Scientific American *is likely to have on cold fusion for the foreseeable future are negative ones. In fact, in their latest issue they take another pot-shot at cold fusion!—EFM*

• — • — •

A subscriber shares with us his letter to a book distributor:

Laissez Faire Books
938 Howard Street, #202
San Francisco, CA 94103

For over three years now, I have had an avid interest in what came to be termed "cold fusion." My interest is a natural extension of my chosen profession, electrical engineering, but deeper than that, it reflects lifelong desires to have control of my own life, protect the environment and decentralize economic infrastructure.

The materials I have ordered from Laissez Faire Books have been quite helpful in clarifying my thinking on economic matters, particularly The Road to Serfdom and other materials by Hayek. I would like to return the favor and help my friend, Dr. Eugene Mallove, formerly of MIT.

Free market forces are what allow people to have what they want most at the best price, but only if they are aware of the possibilities. We all need and want cheap and clean energy, but it seems that few of us are aware of the amazing realities on the scientific frontiers. Dr. Mallove decided to write directly from his experience at MIT during the aftermath of the announcement by Drs. Fleischmann and Pons in March of 1989 at the University of Utah. You will likely remember that they stated that they had devised a means to induce nuclear reactions in a table-top apparatus. Failures to replicate their experimental results by most of those excited scientists inclined to either confirm or disprove led to a condemnation of their work by Federal Government officials. The book that Dr. Mallove produced is *Fire from Ice*. He has another book in the works to further document events that an individual in his position has unique perspective to reveal.

I have been consuming the issues of his magazine, *Infinite Energy*, since his first issue's cover story picturing a Nobel laureate, Dr. Julian Schwinger, explained why Schwinger believed that the reactions in question are unmistakably nuclear. Every issue is more astounding. Although not every topic that has amazed people will pan out, the basis is rock solid. Beyond question, massive excess energy, nuclear transmutations, isotope shifts and electrical phenomena I could only hope to dream about are meticulously and authoritatively documented. Dr. Mallove has made this appeal to the educated non-specialist in order to overcome the criminal inertia of academic and governmental structures designed to find and promote such discoveries.

I implore you to contact Dr. Mallove at 603/228-4516 and obtain any and all materials available. I would really enjoy seeing his books advertised by your business. I would also like to see *The Structure of Scientific Revolutions*, by Thomas Kuhn, a true classic whose pages are being played out as I write this.

In the short term, the impact on our industrial and economic infrastructure (not to mention metaphysical assumptions) of the technologies that are, by these reports, well confirmed, will be upsetting but inevitable, as unimaginable opportunities unfold. The longer the reality is allowed to be debunked, the more traumatic the transition. The U. S. has already lost incredible opportunities. Fleischmann and Pons are working for the Japanese. The long-term impact is, of course, much better for all of us. Lower real costs for every product on the market, much less pollution of all kinds, a solution to the generation of nuclear waste and a probable way to safely, even profitably, dispose of nuclear waste are but a few of what I envision as outcomes of the discoveries referenced.

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• — • — •

Thank you for your excellent publication. I have a complaint about the layout. In my opinion it is far too confusing for those who want to follow a particular story—you have to jump from page to page to follow it. Perhaps a more structured approach to *Infinite Energy* would be more helpful to your readers.

Bulk Copies of *Infinite Energy* Are Available.

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However, my main reason for writing is to tell you that your main problem in convincing the world about Cold fusion is not the data but that your foes have political clout.

So what you need is an ally who has good political connections, a good source of funds, and who is above reproach. This ally should be able to check your data within a reasonable time frame.

Once this is done, they should be able to announce that they endorse the claims that are made for Cold Fusion. The ally I have in mind is American Greenpeace or Greenpeace International.

I feel you should approach Greenpeace with a proposal that their organization should donate $4 million for two special prizes each of two million dollars: one for transportation and the other for home power —to power the home of a normal family for a year. Both the endorsement and the news about the prizes should be announced at a major news conference.

Peter Mosley
Horsham, West Sussex
England

Thank you for your kind suggestions. Our foes do, indeed, have political clout. And those who should be our natural allies—such as Greenpeace— have shown not only profound indifference to Cold Fusion , but occasionally outright hostility. Your idea for technology prizes is excellent—we have thought of that too. If you know someone who'll put up the prize money, we'll gladly be the contest judges.—EFM

• — • — •

I just returned to my accumulated mail in El Paso and was greeted by issue #8 of *IE*. I was overwhelmed by Dr. Aspden's article—the enormity of his grasp of free energy science.

One of the stopovers in my recent six weeks of traveling, of all things, was the midwest conference on UFO research held at Branson, Missouri. I have a keen interest in the Crop Circle (now called Patterns) phenomenon and attended Colin Andrews' workshop, where I met an individual who was elated to hear about *IE* magazine. Please send him a copy ($10.00 money order and address enclosed).

I had intended to send my copy to him, but I decided instead to forward it to Mike A. Green, PhD at Berkeley National Laboratory (Formerly Lawrence Berkeley Laboratory). I visited him on this same trip and left him with my *IE* copies #1-#7, because he was not aware of your publication, but was greatly interested. His PhD work in mechanical engineering was sponsored by DOE in the field of forced-flow cooled superconducting magnets. I was privileged to associate with Mike since 1977 when I joined Lawrence Berkeley Lab. I took early retirement in 1985 as a senior cryomechnical engineer.

I have requested that Mike make the *IE* copies available to the library which would be the most appropriate at the Laboratory. Dr. Aspden's article confirmed a suspicion I have held for some time: Instead of investigating superconductivity from an electrical approach, maybe they should be considering the light energy or aetherial approach!

Thanks for your courageous efforts. They are appreciated by us all who are in search of the truth.

Bill Burns
El Paso, Texas

Thank you, Bill! It is always heartening to learn how readers of Infinite Energy *are spreading the word to their colleagues in other fields.—EFM*

LATE BREAKING NEWS:

As we went to press with Issue #9, we noticed an article in the inside pages of the Japanese newspaper *Yomiuri Shimbun*, September 25, 1996. The reporter has no concept of the difference between "ultra efficient" and "over-unity." As usual, the device is described as "reduced-energy," meaning *highly efficient*, even though conventional electric generators are almost as efficient as they can be. Hmmmm! As described, the machine appears to be, on its face, a violation of the First Law. The article refers to the inventor by his first name frequently, which is most unusual in Japan, but in this case it is done to distinguish him from the other members of his family, particularly his famous daughter, who is probably the only reason the reporter bothered to come!

Kohei Minato (left), father of the singer Hiroko, tests his new type of ultra-efficient electrical generator, with his wife Nobue [holding the multimeter].
-Courtesy, *Yomiuri Shimbun*

Translation by Jed Rothwell:

Father of popular singer "Hiroko" INVENTS REDUCED ENERGY GENERATOR

Attracts Attention in Taiwan and China

The father of popular star singer Hiroko, Kohei Minato (age 51), has invented a new type of reduced energy consumption generator after working for twenty years. The device employs magnets. It goes beyond an amateur hobby invention; he has been granted patents in Japan, the U.S., and Europe, and he has made deals with manufacturers in Taiwan and China, countries which suffer from lack of natural energy resources.

"HIROKO" is more popular in the U.S. and Europe than Japan, having appeared in the hit charts there. Kohei acts as her producer, while he supervises a research center "Japan Creation."

His office in the Yottsuya section of Tokyo is cluttered with posters of HIROKO. Next to the office is a room that looks more like a small factory assembly area than an office. In it, he displays his recently perfected generator. It is simple in principle. Powerful magnets are arranged around the perimeter of a rotating disk, evenly spaced apart. Like-poles face out, where another magnet is placed, which repels them when they get close, which causes the disk to start turning.

Unless the shape and angle of the magnets is right, the repulsion does not work right. The inventor created the prototype by trial and error, assembling and reassembling the device to find the optimum configuration of

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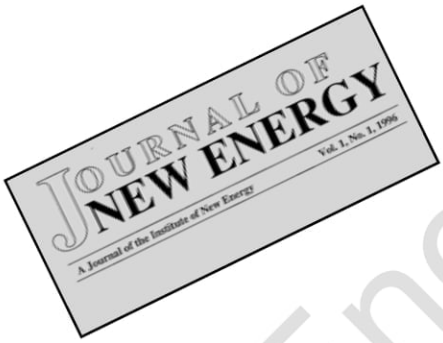
shapes and angles.

As a pianist, Kohei trains singers, and has written a manual on performing arts techniques. His life had nothing to do with machines or technology, but he says, "When the oil crisis hit, I worried about the future of Japan, and I made up my mind to work on high-efficiency energy devices." Studying on his own, he "thought of a way to use magnets to generate electricity." So he set up shop next to the office, and using drills and tools in his hands more used to playing piano, after a great struggle he reached the point where he was awarded a patent. Being an amateur -- and what's worse a pianist —he was not able to attract serious attention in Japan, but the response overseas was unexpectedly strong.

He got inquiries from people in Taiwan who wished to examine the actual machine, so in June he brought the machine there to be evaluated. Industrial researchers gave it high marks, and concluded an agreement to manufacture it. The Taiwanese say they plan to manufacture ultra-miniaturized versions to serve as power supplies in things like portable telephones.

- T. Okamoto

The*EDITOR'S COMMENT: Who would put a rotary magnetic device in a portable telephone if it were not generating electricity? This is either real or nonsense. There is no middle ground.—EFM*



Published by the
Fusion Information Center
P.O. Box 58639
Salt Lake City, Utah
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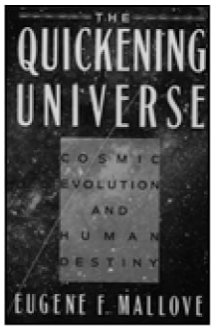

1987, St. Martin's Press, hard cover, 268 pages, illustrated by the author.

What Gene Mallove was writing about—*before* cold fusion and New Energy!

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Summary Report on the Second International Low Energy Nuclear Reactions Conference (ILENR2)

by Jed Rothwell

VENUE AND THEME OF THE CONFERENCE

This conference was held on September 13-14, 1996 at the Holiday Inn, College Station, Texas, adjacent to Texas A&M University, because it was banned by the university [22]. It was chaired by Distinguished Professor John O'M Bockris of Texas A&M and George Miley, Professor of Nuclear Eengineering at the University of Illinois. The conference was organized by Dr. G. H. Lin. The focus was transmutations of elements in the cathode (so-called "host metal transmutations"), rather than excess heat, neutrons, and other well-known attributes of the cold fusion effect. Most papers described transmutations in conventional electrolysis cold fusion experiments, but other approaches were discussed, including ultrasound loading [7]; arc discharge synthesis of iron, which the author concludes was an artifact [10]; and some variations of ancient alchemical techniques [9, 12].

I consider this one of the most important meetings in the history of cold fusion. These results constitute a major turning point in the search for nuclear ash and a mechanism. I consider it now proven beyond doubt that the Pons-Fleischmann effect often (perhaps always) causes both fission and fusion of heavy elements in the cathode. It appears to be nothing like a light-element plasma fusion reaction. [Ed. Note: But such light-element fusion could still be a *part* of the phenomenon—EFM]

A complete list of papers read at the conference is attached. Footnote numbers in square brackets refer to this list.

Please note that I was not able to attend all sessions, and I have not (as of this initial writing) received the video tapes or proceedings, so I cannot comment on several of the papers. I am depending on handwritten notes. I have little knowledge of theory, so I have nothing to say about the theory papers [11, 14 - 18].

Here are more sources of information about this conference:

1. All sessions were videotaped. Copies can be purchased from Cold Fusion Technology for $125 for a set of six tapes. Contact Cold Fusion Technology, P.O. Box 2816, Concord, NH 03302-2816. 76570.2270@compuserve.com.
3. Hal Fox will publish the proceedings.
4. We will publish more summaries and selected papers in the next issue of *Infinite Energy*, after the ICCF6 conference in Japan.

ILENR2 Conference participants outside College Station Texas Holiday Inn. Pioneering science conference banned from Texas A&M University Campus.

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DESCRIPTIONS OF MAJOR PAPERS

Here are some of my notes about the papers which I considered most important. There are others I would like to discuss after I see the videos and formal papers.

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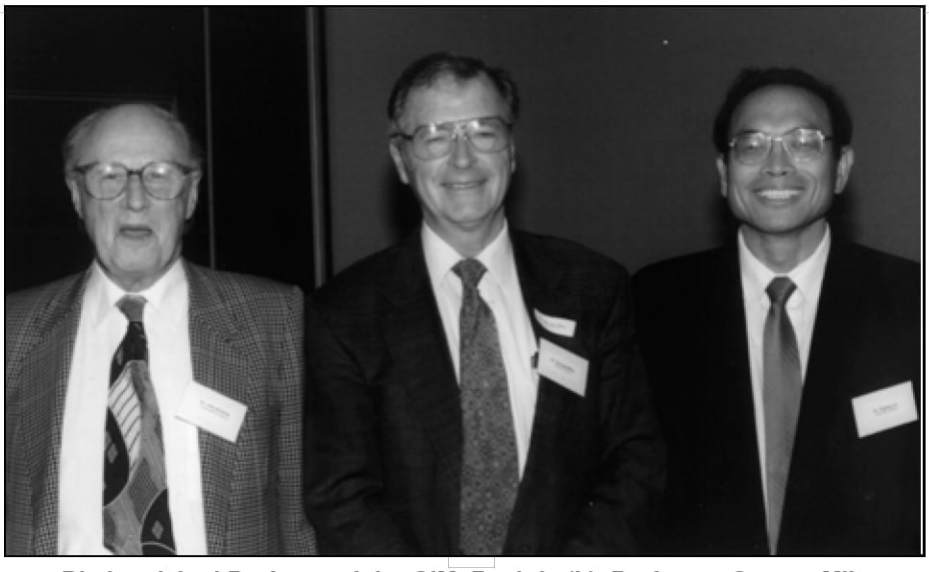

Distinguished Professor John O'M. Bockris (L), Professor George Miley and Dr. Guang H. Lin
ILENR2 Co-Chairmen and Conference Organizer

Miley [1]

This was the most outstanding paper, and one of the best presentations I have ever seen. Miley began by describing his previous multilayer thin film flat plate reported on at ICCF4. As he said it was a great success insofar as the thin film heated up anomalously and peeled off. He described this as a good example of what Edison called learning "700 things that don't work." Miley personifies the good humored, dogged persistence required to solve big problems like cold fusion. As he said, he started out a plasma physicist in 1989 and he has learned every instrument and technique in cold fusion.

He is working CETI-style metal thin-film coated beads packed in 3 to 5 layers. The beads are fabricated by the Materials Science Department at the University. They have devised a new type of sputtering machine that shakes the beads, levitating and rotating them to produce less than 10% deviation in coating thickness. Miley says the sputtering technique simplifies the problem because it does away with the need for a copper flashing, reducing the number of elements at the start. In conversations he has also told me that he thinks the coating is tougher and the beads will generate heat more readily than Patterson's electrodeposited beads.

Miley's has made a great effort to prevent contamination in the closed, flow-calorimeter. He describes contamination as his greatest worry.

He has performed 20 runs to date. He has performed the most extensive analysis on run #8, done in March 1996. The analysis is "very tedious," taking weeks of hard work. He presented voluminous comparative charts comparing data from different runs. He uses four techniques to measure elements and isotopes: NAA, SIMS, EDS and AES (described below). He finds that up to 40% of the Ni is transmuted into a wide variety of other elements including Si, Ti, Cr, Mg, Cu, Fe, Ag, Cd, Pb, Yt, Zr and Zn. (As Professor Dash said of his own results "you see everything but the kitchen sink.") He sees isotopic shifts in many elements, particularly Ag. Unfortunately, the largest shifts were in the low concentration elements, which are the hardest to measure. In one case he measured Cu to within 1% but Ag to within only 5%. Nevertheless, he is sure he is seeing unnatural Ag isotopes. The new elements are not distributed homogeneously through the cathode, the distribution patterns are different for different elements. Zinc is found in about equal density throughout the cathode, while silver is found in the deepest level of the thin film, next to the bead. Miley said "it isn't diffusion – there are no peaks at the surface." Miley says he is "quite confident of the analysis method" and the only potential error is contamination. In other words, he is sure he is seeing iron instead of nickel, the only question is where did it come from.

Some runs that produced little heat but showed massive transmutations. Miley thinks this happens when *endothermic* nuclear reactions dominate.

Miley has succeed too well in finding transmutations. He has found that Pd, Ni, Ti and Au all react to some extent. It is becoming a little difficult to select material suitable for electrolysis in a blank cell that

Prof. George Miley introduces his talk:

I am going to talk about transmutations in thin film nickel coating. Many of you know me, I think, in this community as editor of *Fusion Technology*, since I have taken the step of publishing papers in this subject—assuming they get through review. This has caused considerable criticism by my colleagues. Most of my research record is in the area of hot fusion, and hot plasmas. I just note that I am also the editor of *Laser Particle Beams* and the *Journal of Plasma Physics*. In fact, I consider myself a plasma physicist. So in the work I am doing now, in the spirit of Professor Bockris' comments—I have been criticized by some of my colleagues in metallurgy, who say: "that guy doesn't know anything about metallurgy. What is he dabbling in this for?" This is an interdisciplinary field, which requires people to keep an open mind. I would say that if I didn't dabble in things, I would never have gotten my other research done. In 1978 I had the first electron beam pumped laser, and I never built a laser before. In '85 I had the first design for . . . an ICF target, and I never designed an ICF target before. So, I have no apologies for doing something that I have never done before. That's what research is all about.

Introduction to the Conference by Professor Bockris

GREETINGS:

Welcome to the Second International Conference on Ultra Low Energy Nuclear Reactions.

I note, in this opening statement the remarkable position of the field. On the one hand, my colleagues in the Department of Chemistry have declared the field to be non-existent end any pretense of a Conference a HOAX! On the other hand, the work a number of you are to present today would, in the opinion of some who know of advances in the field, stand with the Great Steps in nuclear research, with Rutherford and Chadwick of 1919 and Hahn and Meitner of 1939.

But, we must forever be on the look out that we do not let our enthusiasm become overly confident and overly optimistic. Although my scientific experience has told me that more is lost through over-skepticism than too much credence, yet we must always try to see if it is not possible to explain our results in terms of the traditional nuclear chemistry of the text book.

Now, I am not the first speaker, I am only the introducer, - and it is therefore with great pleasure that I do my job, and introduce the first speaker here, Professor George Miley of the University of Illinois.

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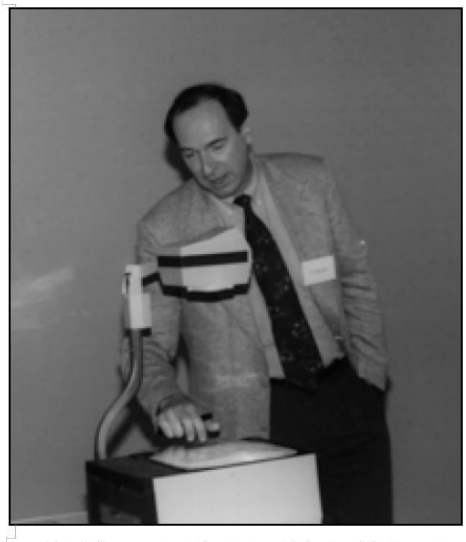
Dr. David Nagel of the U.S. Naval Research Laboratory—Unheeded voice in Washington, D.C.



Dr. Thomas Claytor of Los Alamos National Laboratory—Has proved tritium for H-bombs can be produced cheaply by cold fusion, but bureaucrats and politicians are not listening. They intend to spend $3 billion on a fission reactor in Savannah, Georgia.

does not transmute! He is using conductive sulfonated-plastic bead for this purpose.

Miley concluded "if fifty percent of what we are talking about is true this revolutionizes nuclear physics."

Miley is not the first to report metal transmutations in cold fusion cathodes. I believe that honor goes to Mizuno, who is usually years ahead of everyone else. But Miley's data is the most extensive, and his experimental technique and exposition are brilliant.

Mizuno [2]

This was similar to the *Infinite Energy* article [see *IE #7*], but with more detail. He described the cell and answered questions about it. He talked about the recombiner, the heater wire around the cell, and other aspects of the static calorimetry. The cathode is carefully prepared, and cleaned by being heated to 200 deg C for 16 hours.

The levels of contamination measured in the cathode and cell components are carefully measured before the experiment, and this data proves that contamination could not possibly account for the elements found in the cathode. One of the cathodes used in this work underwent "heat after death" (heat production after removing electrical power), in the first recorded instance of this in the literature other than what Drs. Pons and Fleischmann have reported. The Delta-T fluid temperature across the cell spontaneously rose 30 deg C and remained hot for three days.

Dash [3]

Dash has been working with Ti cathodes and slender resources. He reports excess heat and transmutations. He uses two air-cooled static calorimeters in series, attached to a data acquisition computer. One cell contains a blank, one a Ti cathode. The electrolyte is in the ratio 0.99 mole D_2O to 0.01 mole H_2SO_4. These are closed cells with recombiners. The wires leading into the cells for electrolysis and the sensors pass through wax, which is not a very good method of sealing a closed cell. The cells weigh a little less after experimental runs because some gas is lost through the wax. In a typical excess heat run, the cold fusion cell consumes 20% less energy than the control, yet it is 4 deg C hotter. This represents a 1.2 watt excess with a 0.6 gram cathode.

After he washes away galvanized contamination from the surface with an ultrasonic jewelry cleaner in de-ionized water, Dash finds that most of the surface is highly pure Ti. This shows the cleaning method works well. But in the material that had erupted from below, he found a mixture of different elements, which were surprisingly unevenly distributed within the ejecta. The SEM photos Dash showed during his lecture did not clearly show that the lumps on the surface of the cathode were ejecta; they looked like clumps of debris that had been deposited onto the surface. However, evidence in his *Fusion Technology* paper demonstrates that it comes from inside. He said that Ti damages more easily than Pd, and it is highly reactive.

To search for transmuted elements, Dash uses an instrument that measures only about 1 part per hundred, "so if you see anything, it has increased ten to the fourth." He has had a more sophisticated analysis done by a contractor, and he would like to do more, but it takes a week and it costs $5,000, which is far more than he can afford.

Swartz [6]

Swartz described meticulous multi-ring calorimetry of a unique design, featuring multiple envelopes within envelopes. This allows high accuracy while persevering the isolation and cleanliness necessary to finding transmutations, where Miley and Claytor trade off calorimetric precision for cleanliness. Impressive as it is, I am not sure I see any necessity for such accuracy in the first place. Whether the excess is 2 watts or 2.102 watts hardly matters as far as I can see. Swartz's calorimetry is as conservative as possible. He measures I*V input and makes no adjustments for gas losses. His electrochemistry is unique in many ways: he uses no salts in the electrolyte, and he reports some of his best excess heat results with natural light water and a gold cathode, which produces 3 to 6 times input.

Swartz hypothesizes that some nuclear ash might be in the form of hydrogen transmuted into deuterium, in a multi-body reaction. This would be extremely difficult to find because deuterium is not radioactive and because there is a great deal of it in the ordinary water electrolyte to start with. A great deal, that is, compared to the amounts that would be synthesized in a nuclear reaction. It would take a megajoule to increase the deuterium content of the water by a few percent. He plans to verify the hypothesis with new in-situ spectroscopes he is now installing. I wonder if it would help if he used purified light water. That technique is difficult, because pure light water rapidly absorbs deuterium from atmospheric water vapor when it is exposed to air.

Swartz describes what he calls the "pi-notch" graph of excess heat with Ni H_2O. This has been noted by others, especially Mills, Thermacore and CETI. You get the most heat with low current density. As current increases, the heat peaks, and it declines as a percent of total input. With Pd, higher current density usually increases loading, which increases the heat geometrically. The cause of the Ni drop-off is a mystery. After Swartz spoke, Miley suggested that perhaps at higher power endothermic nuclear reactions predominate, producing more transmutations but less heat. Swartz thought this is an interesting idea.

Kim [14]

This was an advanced theory paper, and all such papers are completely over my head. I note, however, that people who *do* understand such things gave this one high marks, but they said it is not specific to a metal lattice, and the mechanisms it describes for overcoming the Coulumb

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Dr. T. Mizuno (standing) listens as Jed Rothwell (also standing) makes a point.

barrier would seem to work as well in a plasma, where they do not appear to operate significantly.

Claytor [20]

Claytor continues to report progress in tritium generation by plasma discharge (sparking) through deuterium gas. His best results to date have been with palladium alloys Pd (90%) Rh (5%) Co (5%). In 12 runs this worked well four times. When he adds a small amount of CO_2 (<1%) to the deuterium gas, the plasma wire often soaks up a larger volume of gas more quickly, and it produces more tritium. Most impurities poison the reaction, but some enhance it tremendously.

The configuration of the anode and cathode in Claytor's device are a little surprising. Bockris pointed out the configuration is inefficient and it will cause uneven loading. This is deliberate. One end of the wire hangs in the deuterium gas, pointing one end towards the anode. Deuterium loads into about half the wire only, it never reaches the other end which is anchored into the rest of the device. (I presume this means the highly loaded, active area is only a fraction of the loaded half.) This is done so that the spark touches only the cathode wire. In previous configurations the spark caused sputtering of other materials, which contaminated the wire. Let me point out here that this is the kind of vital detail about the anode-cathode geometry that often fails to make it into a formal paper. A person attempting to replicate the experiment might miss the point, and choose another configuration that gets contaminated easily. The subject came up in the question and answer session after the lecture. This illustrates why we need more meetings, and more open discussion and give-and-take.

Hal Fox of the Fusion Information Center in Salt Lake City and Rod Neal of Morningstar Corporation (Cincinnati, Ohio) discuss remediation of radioactive thorium by the Morningstar electrochemical process.

Claytor pointed out potential economic value of this research. The Defense Department needs tritium to maintain nuclear weapons. It plans to build a $3 billion dollar reactor to replace the Savannah River Plant, which has produced the U.S. supply of weapons-grade tritium until now. Tritium generated by conventional methods costs $30,000 per gram. It is difficult to say what it would cost with cold fusion methods, but it would be at least one and possibly two or three orders of magnitude cheaper.

Claytor mentioned, in passing, that the U.S. State Department is paying Russian Scientists to do cold fusion experiments. I find this hilarious yet infuriating. Apparently, the U.S. Government subsidizes academic freedom and cutting edge physics in other countries while it suppressed them things at home.

In conversation, Claytor described a CETI replication he is performing. He is using a small number of beads, which limits input to a fraction of a watt. The cell appears to be producing about 300% excess heat, but both input and output are close to the noise level. Like Miley, he has sacrificed calorimetry for cleanliness, because the purpose of the experiment is to look for transmutations, not heat.

Nagel [19]

Nagel directed cold fusion research at the U.S. Naval Research Laboratory in Washington, DC. He gave an excellent, wide-ranging presentation describing theory, experiment, and management. He crammed a dizzying amount of detail into a 20 minute presentation. Six experiments were performed in Washington, and the lab fabricated cathodes for Miles at the Navy's China Lake Weapons center. Miles has reported continued success in finding excess heat and helium, but unfortunately only one of the six in-house experiments produced results which could be reproduced subsequently. Most of this work was of the highest quality, so it is a terrible shame they did not get better results. All experiments in Washington have now been terminated for lack of funding. Nagel described how he stuck his neck out many times asking for funding at meetings at the OSTP, DARP, DSWA and other federal and military agencies. He continues to do so in spite of the limited success of his own research because, as he puts it, he recognizes that the world is not limited to the Navy and the results from places like SRI, IMRA and Los Alamos must be taken into account.

Some people critisized the Navy research for producing so few positive results. I pointed out that given the state of the art in 1989 and 1990, their success rate was not bad, and it was in in line with labs like SRI. The difference is that SRI had enough money to run the experiments many more times than the Navy did.

Ohmori [20]

Ohmori, Mizuno, and Enyo report excess heat and transmutations with gold cathodes and light water. He also observ-ed dramatic crater-like damage on the cathode surface. Ohmori works with the same

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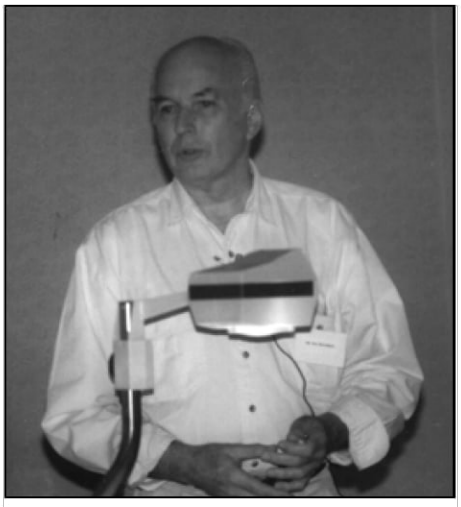


Kenneth Shoulders, who thinks electron charge clusters, the subject of his patent, may promote observed transmutations.

kind of closed static calorimeter that Mizuno described [2]. This is a stainless steel cylinder lined with Teflon on the inside. For these experiments, this simple design is better than a flow calorimeter, which has many nooks, crannies, hoses, and pumps where contamination can hide. The CETI cells require a flowing electrolyte calorimeter to keep the bead pack wet and to remove heat from inside it. Ohmori's electrochemical knowledge and technique are superb.

RESULTS COMMON TO MANY EXPERIMENTS

Here are some general statements about the results seen in the electrochemical cells and in the ultrasound-loaded metal sample. The results from different experiments in different labs were remarkably similar, something we must admit we are not used to seeing in this field.

Damage was seen at the same depth as the transmutations. SEM photos of many cathode surfaces showed eruptions of material from inside, looking like the surface of the Moon. [2, 3, 21] It was this damaged material and the areas around it that was transmuted. In cases where the transmutations occurred well below the surface the material was not ejected but damage was seen when the outer layers were removed. [5]

The transmuted elements were not uniformly distributed. Areas with no damage often remained highly purified metal (Pd, Ni, Ti or Au).

This is a large effect, easily detected. In many cases, large amounts of the metal were transmuted. Miley [1] reported up to 40% of the total metal was transmuted, where the starting metal was better than 99% pure. Minevski said that in the layers where transmutations occurred, up to 70% of the material was no longer palladium.

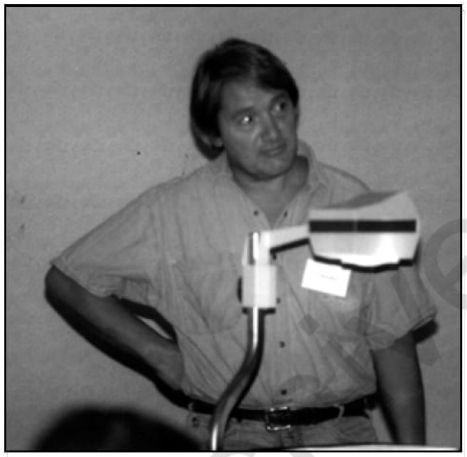
Mizuno reported three peaks of new elements: light, medium, and heavy elements. Miley said he saw the same pattern, with the three peaks moving up or down the spectrum depending on the metal he started out with (Pd or Ni).

COMMON METHODOLOGIES

A variety of different detection instruments must be used to verify the transmutations. These include Neutron Activation Analysis (NAA), X-ray spectroscopy (EDX or EDS), Auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS). The speakers all emphasized the importance of cross checking with different methods. As Miley puts it, with SIMS "the absolute calibration is lousy." In other words, with SIMS you can detect tiny differences between very close isotopes and species (like D_2 molecules and helium-4), but when you first start out you never know where on the spectrum you will land. Other methods are more accurate but less precise. This problem should not be exaggerated. Any instrument will verify that 40% of the nickel cathode has turned into silver, silicon, copper, and so on. Indeed, if Miley ever runs a cell with a liter of beads for six months, he will be able to refine the material and make the new elements visible to the naked eye. He will have more silver and gold than you would find in all the contamination in the building. You do not need high precision to verify nickel has turned into iron. You need it to find out whether the isotopes distributions are unnatural, and to draw useful conclusions about the nuclear transformations at each step.

The NAA has the useful property of analyzing many atoms over a large mass simultaneously (4 or 5 beads, in the case of the CETI device). This is important because the material is inhomogeneous. SIMS looks at only one tiny spot on a sample.

People will argue that the excess heat might be caused by chemical reactions, even when it is a hundred thousand times too big for that. But nobody will say that chemical processes convert nickel to iron. Dash, who had the smallest budget and the least sophisticated instruments, was concerned that some of what appeared to be elements might have been oxides of other metals, which he could not distinguish, but all other speakers expressed confidence that they could identify specific elements. The only question was, where did the elements come from, contamination or transmutation? Obviously, contamination is the biggest concern. It is well known that a cathode will attract many impurities in the electrolyte, and the electrolyte will, in turn, leach new impurities out



Dr. Roberto Monti of Italy claims that his "alpha extended model of the atom" can explain transmutation evidence.

of the cell wall. (This is sometimes referred to as the "galvanized gunk" problem.) Indeed, one of the best methods of producing ultra purified electrolyte is to run for a long time with a scavenger electrode which picks up "dirt." The steps taken to reduce contamination and to distinguish between contamination and *in situ de novo* synthesis are based on common sense:

1. Rigorous cleanliness and isolation. In some cases, precision calorimetry was sacrificed to ensure cleanliness. Teflon coated vessels are recommended to prevent leaching from cell walls and tubes. [1, 2, 20] Glass should also be avoided. The electrolyte should never be exposed to metal container surfaces.

2. Pre-testing of all materials including cathode, anode, electrolyte, plastic bead cores and so on to inventory contaminants. Ohmori, for example, to show that the mass of transmuted material in the cathode was 100 times greater than

3. Some workers [2, 21] used scavenger cathodes to purify electrolyte. Bockris recommends this method.

4. In bulk cathodes, transmutations were seen well below the deepest diffusion level galvanized material reached. Even with thin film beads, Miley found elements at lower levels that were absent from the surface, particularly silver. This fact alone defeats all contamination hypotheses, since the beads are tested before the experiment and significant levels of silver are never found. The metal is always more than 99% pure to start with, whereas after the experiment nearly half of it is something else. If this is contamination from outside the cathode, it has worked its way under the surface layers without leaving a trace.

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5. The effect is not caused by diffusion; no peak in total mass is seen at the surface. The isotope shifts cannot be caused by diffusion separation; the heavier isotopes of a given element are not always at the surface -- indeed, sometimes they are altogether missing.

6. Miley has spiked the cells with silver to see if it works its way deep into the cathode. It doesn't.

7. In bulk cathodes, xenon gas is captured within the metal lattice. It cannot be pushed in by electrolysis, which has no effect on it, and it is never found as contamination in measurable amounts in the electrolyte or cell material. Xenon is not found in the thin film cathodes. It might be generated and then escape.

MEETING BANNED FROM TEXAS A&M, OTHER SOUR NOTES

Last year's conference (ILENR1) was held on the grounds of the university, but this year a 12-person Chemistry Department advisory committee voted unanimously to ban the meeting, so it was moved to the hotel. The Department Head refused to state the reason why the meeting should be banned. According to a memo circulated by Bockris [22] (reprinted here), a committee member said the reason was that the field of cold fusion does not exist and that "any suggestion it does constitutes fraud" and that a conference is "a joke." Committee members were given Storms' 1996 review, information on the Reifenshweiler experiments, and references to the peer-reviewed literature, but this did not sway their opinions.

While the meeting was productive and exciting, the fact that it was banned by the chemistry department did leave a sour taste. During the discussion period, we discussed patents, always a dismal subject in this field, and we heard another sour note from a "skeptic." Dr. Natowitz, head of the Texas A&M cyclotron lab, was asked to summarize his impressions. He dismissed all findings except the tritium work at Los Alamos, which he refused to comment on. (However, the previous evening, in private conversation, he also vehemently rejected all reports of tritium.) He suggested that the elements found in the cathodes come from contamination. I pointed out that the workers rigorously exclude contaminants; for example, Ohmori reports that there is 100 times more transmuted material in the cathode than all contamination in the electrolyte and all other cell components. Natowitz suggested that the isotopic anomalies are caused by electrolytic diffusion separation of elements. I pointed out that this method of separating isotope requires thousands of passes for light elements and millions of passes for heavier elements; and that this separation always leaves heavy isotopes on the surface and lighter ones deeper in the lattice, whereas much of this data shows no isotopes on the cathode surface, or heavier isotopes lying deeper than light ones. In other words, the mechanism he proposes is millions of times too small to explain some data, and it is flatly contradicted by the rest. He did not respond to my comments, or to similar remarks by Bockris. [*Editor's note: To paraphrase a recently deceased U.S. Vice President's remarks in the 1970s, is Natowitz being a nattering nabob of negativism?" —EFM*]

MY IMPRESSIONS & SPECULATION

I believe we have turned the corner in the long search for the mechanism of the Pons-Fleischmann effect. Host metal transmutation is the key. Years ago, everyone assumed the effect must be caused by the fusion of light elements. Miles, E-Quest, and others found helium ash roughly commensurate with conventional deuterium fusion. No doubt they did see helium; we cannot dismiss these earlier results. Yet many others made heroic efforts to look for helium, but found none. I conclude that sometimes helium is produced, and sometimes it is not. The effect produces fission and fusion of both light and heavy elements, in both exothermic and endothermic reactions. All these reactions occur simultaneously in different spots in the cathode. The transmuted elements are not uniformly distributed. No doubt various complex parameters like current density, loading, and pre-existing dopants cause the reaction to produce different products at different stages, in different layers of the metal. Perhaps we shall someday discover a simple law that governs the process, but perhaps not. Chris Tinsley speculates that the process is as complex as biochemistry, so we will discover more and more ramifications and complex reaction paths, and ever-increasing detail. He points out that cell metabolism of sugar is much more complicated than what happen when you burn sugar in a dish, even though the basic processes (oxidation) are the same.

Perhaps someday we shall learn to "tune" the reactions to produce concentrated excess heat or transmutations that produces rare and expensive elements.

How these transmutations might occur is, of course, a total mystery. On the face of it, room temperature transmutation of stable elements without radiation would appear to overthrow a great deal of established theory. That is none of my concern, and I have no opinion as to whether this will require wholesale changes to the textbooks. My point is, the evidence that such transmutations do occur is now overwhelming. In some experiments, the total mass of reaction products approaches macroscopic levels: if Miley runs the experiments much longer he will produce visible traces of gold, mercury, and other elements transmuted from nickel. The possibility of contamination has already been eliminated by the sheer volume of rare elements produced by the reaction: you cannot find that much gold, mercury, xenon, tritium, or mono-isotopic copper in the whole cell, or even the entire experimental apparatus, or for that matter, in the whole building. It is becoming analogous to the excess heat, which in some cases would produce thousands of times more chemical ash than you could fit into the cell.

The fact that both endothermic and exothermic reactions occur explains why the heat varies so much — some reactions must be swallowing up heat as quickly as others produce it. Somehow the energy is transferred through the lattice. The mechanism is imperfect, because the metal lattice often heats up and self destructs. I suppose the exothermic reactions must occur in order to release the prodigious energy needed to drive the endothermic ones, but if that is not the case then perhaps it would be possible tune a cold fusion device so that endothermic reactions alone take place, making it into a miniature refrigerator. It would be a great way to cool a computer chip. [Editor's note: That joke from 1989 about cold fusion begin *really cold* —the "cold fusion refrigerator" may have been prophetic!]

The self-destruction leads to eruptions of molten metal. It might even be vaporized metal. It quickly solidifies, leaving pinholes in the material, craters, and dramatic, porous frozen ejecta. Miley's thin film frequently sheds chunks. The cathodes are rough after the experiments, and bits of metal are trapped in the circulation filters. This damage makes me wonder if cold fusion can be made into a practical heat-generating technology. Ken Shoulders thinks that these problems can be fixed with some clever engineering, even self-repairing devices. He points to the example of the tungsten incandescent lamp filament. The tungsten constantly boils off, but the vapor settles back and condenses on the filament itself. That's fine for a filament, but cold fusion cathodes apparently require special metal lattices. It is hard for me to envision a cathode undergoing continuous repair in situ.

I predict that unorthodox theories about ZPE or shrinking hydrogen atoms will fade. I believe there is now enough nuclear ash

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in cathodes to account for all of the heat, and it may also explain the lack of heat in some cases. Chris Tinsley predicts that whether there actually is enough ash or not, people will jump to conclusions and assume there is, and they will drop ZPE and other far-out theories like a hot potato. He fears they may rush to anoint host metal transmutation, because the evidence for it is so clear. They may "raise assumptions to the status of proven fact," and forget to look for evidence of other processes and non-nuclear processes such as ZPE. Gene Mallove concurs. After all, we spent the last seven years looking only for light element transmutations. This leads to a question that has been haunting me for months, ever since I first heard about Mizuno's results. Why did this take so long? D. Rolison reported evidence of heavy element transmutation years ago. Why was there no follow-up? Mizuno says the other Japanese researchers have completely ignored his and Ohmori's findings. I hope they pay attention to Miley when he reports his results at ICCF6. For that matter, why did it take so many years before people did a serious replication of Ni H_2O cold fusion? The pace of this research is still much too slow, and the scope of investigations is still much too cramped by our preconceptions about what must be happening.

A VALUABLE FREE-DISCUSSION PERIOD

After the three formal presentations on the second day, two hours were devoted free discussion, chaired by Geroge Miley. This was one of the best open discussion periods I have ever had the pleasure of attending. Perhaps the number of people attending, 46, was just right. In larger meetings these discussions are unwieldy, and in smaller meetings people have nothing left to say after two days. Or perhaps these were the right 46 people. There were no earthshaking declarations or revelations, but people exchanged good ideas about how to do control experiments, what constitutes a blank experiment, how to distinguish contamination from transmuted elements, how to set up particle detectors and so on. It was a productive discussion, it did not get bogged down in arguments or misunderstandings. Even our resident skeptic, Natowitz, gave an interesting talk and made his points crisply.

Bockris make the most important point, when Miley asked, "What can we do to get this back to a respectable field?"

> I think the one overwhelming thing— a cold fusion experiment that works. At a planned time. That's the overwhelming requirement. We are still based upon the fact that we say "uhh, uhh, maybe, uhhh." That is still our state after five years. We can't guarantee to do an experiment at a given time, in a given situation. That's very, very bad. People like Ed Storms have written papers recently -- erudite papers, much of which I agree -- indicating in very great detail what is necessary to reproduce the experiments [See *IE*#8]. And if you take Ed's contributions alone, my goodness! -- so to speak -- no wonder you don't often get one to work!
>
> We should concentrate on that. I have been saying this for a couple of years: we should have a project for reproducibility. Reproducibility, that's the whole point.

Friends and enemies of cold fusion agree. This cannot be repeated too often! The only thing better than a reproducible experiment would be a commercial product for sale in the stores. (Such a commercial product need not be reproducible, by the way. Things like Pentium processor are too difficult to be reproduced by anyone but Intel, but nobody doubts they are real.)

In response, Dash said that he thought his experiment was repeatable and he would be happy to assist others with it. The experiment he is now working on was done last year as part of a graduate thesis, and repeated this summer by the two high school students Dash hires every year. Several people said they would take up Dash's offer. James Reding, president of CETI, said that his cells are generally reproducible, although they do have trouble achieving the same performance batch to batch, and they have difficulty with things like the flow through the beads being blocked by contamination, and so on. He said that CETI has begun selling demonstration kits. He did not discuss pricing or terms. Jim Dunn, of NASA's Center for Technology Transfer in Westboro, MA, said that he is working with CETI and several other groups to bring out cold fusion "educational products" and "bench top research kits."

Dr. Mitchell Swartz of Jet Energy Technology made an excellent point about the role of theory and the fallacy that there must be one, over-arching theory:

> I think one thing that our antagonists do is make us say there is one theory. [D. Morrison] always says that the reason this field does not exist is [the lack of this one theory]. I want to challenge that. We have theories of isotopic loading of the fuel into the metal. We have theories of catastrophic redistribution. We have theories of what destroys the metal even when we get the reaction, and the theories of the Coulomb barrier. This has two effects. One is, I think the fact that there are multiple theories on separate subjects — it is not all about one thing, it is not all just about the Coulomb barrier— proves the field is real. And two, I think if we just try to forget those other issues [loading etc.], I think we are on weaker ground.

I do not agree that presence or lack of theory can make a field of science "real" in any sense, since many now discredited fields were rife with theory, but I agree with the rest of these sentiments. Suppose a theory explains how the Coulomb barrier is overcome and an aneutronic nuclear reaction occurs. This may not serve as a useful guide to loading hydrogen or picking the best alloy. Miley abandoned the use of multilayer film and went to thin film stretched around beads instead because the bead geometry holds together better. That is clever engineering, it has nothing to do with nuclear theory. The flow of cooling water through a bead pack is a critical issue for the CETI cell design. Problems like this have been addressed in industry, particularly in fission reactor design. The techniques that have been developed to deal with this work-a-day problem may be more critical to the immediate future of cold fusion than a nuclear theory would be.

Boundless Enthusiasm

Let me close by nominating Professor John Dash for the greatest contribution to cold fusion reported at this conference. Mizuno was first to deal with transmutations, and his results and Miley's are more conclusive, but Dash has done something wonderful. When the University is in session, he recruits undergraduates to work on the experiments, and he gets ten applicants for every spot. During summer vacation, he puts high school students to work at the lab bench. They become madly enthusiastic about cold fusion, and they go around telling their friends about their adventures. This is what we need more than anything else: new blood, new ideas, and the boundless enthusiasm of youth.

FOOTNOTES

This is a list of all papers presented at the conference in the order they were presented, plus a memo circulated by Bockris.

1. G. Miley (University of Illinois), Nuclear Reaction in Palladium-Hydrogen System

2. T. Mizuno (Hokkaido Nat. University), Reaction Products Induced by Isotopic Changes of Electrolysis. See also Infinite Energy, Issue 4, p. 9.

3. J. Dash (Portland State University), Excess Heat and Unexpected Elements from Electrolysis of Acidified Heavy Water

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with Titanium Cathodes

4. S. Szpak (COSC, Navy), Nuclear and Thermal Events Associated with Pd + D Codeposition

5. Z. Minevski (Lynntech), Two Zones of "Impurities" Observed After Prolonged Electrolysis of Deuterium on Palladium. See also: Infinite Energy, combined issues 5 and 6, p. 67.

6. M. Swartz (JET Energy Tech.), Deuterium Production and Light Water Excess Enthalpy Experiments Using Nickel Cathodes

7. R. George (E-Quest Sciences), Isotopic Ratio Anomalies Induced in Palladium by the Application of Intense Ultrasound

8. H. Fox (Fusion Information Center), Low-Energy Nuclear Reactions in an Electrolytic Cell

9. G. H. Lin (Texas A&M University), Anomalous Radioactivity and Unexpected Elements as a Result of Heating Oxide Mixtures

10. T. Grotz (Wireless Engineering), Synthesis of Iron via Arc Discharge through Activated Carbon

11. K. Shoulders, Observations on the Role of Charge Clusters in Nuclear Cluster Reactions

12. R. Monti & E. Bauer (Burns Development Ltd.), Low Energy Nuclear Reaction: Experimental Evidence for the Alpha-extended Model of the Atom

13. A. Michrowski (Planetary Clean Energy Association), Advanced Transmutation Processes

14. Y. E. Kim (Purdue University), Nuclear Physics Mechanisms for Gamow Factor Cancellation in Low-Energy Nuclear Reactions

15. A. Cau, Natural Nuclear Synthesis of Superheavy Elements

16. G. S. Rabzi (Ukrainian International Academy of Original Ideas), Natural Cold Fission - Natural New Energy - Natural New Physics

17. E. Lewis, Novel Hypotheses Concerning the Production of Elements, Superconductivity and Anomalous Radiation

18. H. Fox (Fusion Info Center), Possible Palladium-Related Nuclear Reactions

19. D. Nagel (Naval Research Laboratory), "Cold Fusion" Experiment, Theory & Management at the Naval Research Laboratory

20. T. Claytor (Los Alamos National Laboratory), Tritium Production From Palladium and Palladium Alloys. See also: *Infinite Energy* issue 7, p. 39 and http://wwwnde.esa.lanl.gov/cf/tritweb.htm

21. T. Ohmori (Hokkaido Nat. University), Isotopic Distributions of Heavy Metal Elements Produced During the Light Water Electrolysis on Au Electrode

22. J. O'M. Bockris (Texas A&M University), Why We are Not Meeting at

Post Meeting MEMORANDUM by Professor Bockris

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September 17. 1996

MEMORANDUM

TO: Prof. E. Schweikert
Department Head
FROM: John Bockris
SUBJECT: Meeting on Ultra Low Energy Nuclear Reactions

The meeting took place on September 13 and 14 at the Holiday Inn with 23 papers and 42 attendees. It was chaired by George Miley and the writer. The organizer was G. Lin. A security guard was posted to prevent disruption by A&M faculty, one of whom in 1995 had attacked attendees. Some of the papers were as good as any in the field. Three or four should not have been accepted.

Miley. Evidence for multiple element formation in thin films of Pd on subjection to protons at high fugacity. Three methods of analysis used. Abnormal isotopic abundance used as criterion of synthesis. High quality work.

Mizuno. Remarkable evidence for new element formation up to 3μ depth in Pd at high D fugacity. Xe and many metals synthesized. Isotopic abundance measured. Impurities from solution carefully distinguished. High quality work.

Dash. Excess heat correlated with formation on surface of new elements. However, isotopic abundance not measured.

Szpack. X-ray emission from cathodes evolving D_2.

Minevski. New element formation at 1μ depth. Distinguished from impurities in surface layers, which were correlated with measured impurities in solution.

George. He_4 found in Pd electrodes irradiated with ultrasound. New elements found at edge of craters detected on surface.

Fox. A semi-presentation of electrochemical method for reducing activity of nuclear wastes (method being patented). Method was said to reduce activity 60-95%.

Lin. Presentation for first time of Philadelphia Project work of 1992. Au, Ru, Rh formed as result of explosive heating of Pb, Hg salts. Level 100-1000 ppm for Au; 1-10 ppm for others. Multiple methods of analysis used. Activity observed but irreproducible and apparently not always connected to significant new metal production.

Grotz. Threw doubts on Sundaresan and Bockris C -> Fe experiment.

Shoulders. Electron "clusters," fired at metals, give plasmoid shapes and new elements in surface.

Michrowski. Attempt at survey of cold transmutation. But, mixed up with apparently irrelevant study of properties of H_2-O_2 mixtures ("Brown's gas").

Monti. Work presented by Bauer. Claimed model of atom could rationalize huge variety of transmutations in the cold. Monti's verbal contribution in discussion incomprehensible to me. Paper lacked indication of detection methods, guard against impurities, etc. Work lacked credibility.

Kim. A theoretical paper which I found difficult to understand. Kim known to Natowitz who praised him as solid character. Conditions found whereby Gamow factor canceled out, would allow nuclear processes in cold. Physical model appeared to involve excitation of nuclei whereupon they became ellipsoidal and unstable. But (cf. Natowitz comment below) theory did not involve solid lattice!

Cau. Has rationalized formation of noble metals by alchemists. Pitchblende was basic substance used and radiations from it caused other nuclear reactions.

Lewis. Haphazard, ill prepared talk, stressing priorities of Japanese transmutationist Matsumoto who began in 1991. But Mizuno claims priority over Matsumoto.

Rabzi: Incomprehensible talk, - though well translated from Russian by student from Humanities. Claimed his group had had success in cold transmutation over 15

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years. Esoteric theory not understood by me. Rabzi is backed by a group of about 15 Russians who have written to me

Fox. Speculations on details of proton capture mechanisms.

Nagel. Reviewed largely unsuccessful NRL work on cold fusion. Admitted privately that effort partly staffed by semiretired persons. Said government apparatus unsusceptible to his (Division Chief's) pleas for funding of cold fusion. Only person who had success (Chambers) succumbed to downsizing shortly after his experimental results became known (according to Claytor).

Claytor. Five year successful effort tritium production. Plasmas emphasized. Most sustained tritium effort. Apparently convinced Natowitz, as to reality of tritium production. High quality work.

Ohmori. Remarkable paper on isotopic distribution of new elements formed as a result of H and D diffusion into Pd. Isotopic abundance studies as chief criterion of new material creation. High quality work.

A fair summary of this summary would be to say that twelve papers gave evidence that nuclear reactions take place in solid lattices in the cold. If this contention obtains still further confirmation, I suggest it constitutes a discovery of magnitude comparable with that of atomic disintegration with high energy neutrons (Rutherford, 1919), and nuclear fission by neutron bombardment (Hahn and Meitner, 1939). It opens a new area of great potential. It has the potential radically to change the ideas of nuclear stability.

It is noteworthy that, throughout the century, there have been occasional suggestions of easy (low energy) nuclear change in agriculture geology and biology.

A two hour open discussion occurred from 10:00-12:00 on Saturday. I stressed the need for a reproducible experiment. Jim Reding of CETI Inc. and John Dash (Portland State University) both claimed 95% reproducibility. Natowitz criticized work for overriding well known nuclear principles, and the reporting of many results seen as impossible on present paradigm. He accepted the tritium synthesis, but supposed all the other papers must contain undetected errors. Why had no radioactive products been detected? Mizuno rejected this, saying he had detected Pt_{197} and its 18 hr decay. Few people had sought radioactivity which in any case had shown up in Kevin Wolf's work. Natowitz pointed out that Kim's theory did not involve the solid lattice.

The 1992 work of Kevin Wolf was raised. Natowitz thought it undesirable that it should have been finally presented by Wolf's sponsors (in 1995.) I pointed out that Natowitz was the Director of the Institute in which Wolf worked. Why did he allow Wolf to bury for 3 years work of such significance?

Lin raised the question of the formation of an organization. There was little enthusiasm. I suggested the Society for Scientific Exploration would be a good umbrella organization. Ed Storms supported this.

It was rumored that one member of the meeting had a commercial production in gram quantities of hafnium, using a cold nuclear reaction approach, and that another (not overtly present) was on the brink of commerciality in respect to the cold nuclear synthesis of noble metals.

A number of persons observed that, in the absence of the Philadelphia Project work at Texas A&M (1992-93) with ideas originating with Joseph Champion, and funding by William Telander (experimentation by Lin and Bhardwaj), the new field of cold nuclear reaction would not now be the subject of study.

WHY WE ARE NOT MEETiNG AT TEXAS A&M UNIVERSITY

I applied to the Department Head, who had sanctioned last year's Meeting. He referred it to the newly formed Chemistry Department Advisory Committee. I supplied each member of the Committee with a copy of Storms' 1996 review, before the Meeting at which a vote was to be taken. I briefly addressed the Committee at the Meeting

The vote was 12 to zero negative, no abstentions.

I asked the Department Head in two memos why he had voted against having the Meeting. He did not reply to this question. I spoke with a Member of the Committee and he said that the opinion was that the field did not exist, that any suggestion that it did must constitute fraud and the idea of having a Meeting to discuss it, a joke. I sent him references to the Reifenshweiler experiments described in *Physics Letters A*. and referred to publications exceeding 1,000 in number. He did not reply.

Texas A&M ranks number 2 in the country in respect to the facilities for nuclear research within a University, (e.g., as in the Cyclotron Institute).

J. O'M. B.

CALENDAR

ICCF5 – Fifth International Conference on Cold Fusion
April 9-13, 1995
Monte Carlo, Monaco

Low-energy Transmutation Meeting (Private) At Texas A&M University
June 19, 1995

The 2nd World Hydrogen Summit
September 28
-October 1, 1995
Montreal, Quebec, Canada

16th Symposium on Fusion Engineering (SOFE '95), *with cold fusion component!*
October 1-5, 1995
Champaign, Illinois

Third Russian Conference on Cold Fusion and Nuclear Transmutation
October 1—8, 1995
Sochi, Russia

Power-Gen '95
(CETI cell demo)
Anaheim, California
December 5-7, 1995

New Ideas in Natural Sciences
June 17-22
St. Petersburg, Russia

1996 International World Energy System Conference
June 19-21, 1996
Toronto, Canada

2nd Low-Energy Transmutation Meeting
College Station, Texas
Sept.13-14, 1996

Sustainable Transportation—S/EV96
Sept. 16-18, 1996
(Sponsor: Northeast Sustainable EnergyAssociation)
Madison Square Garden, NYC
(*Infinite Energy* Magazine had a booth at the trade show 9/17-18)

ICCF6—Sixth International Conference on Cold Fusion
October 13-18, 1996
Hokkaido, Japan

ICCF7—Seventh International Conference on Cold Fusion
1997, autumn-winter
Scheduled for the U.S.

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Editors' Introduction: This is one of the most important technical papers we have ever published. It is a preprint from the Second Internaitonal Conference on Low Energy Nuclear Reactions, held near Texas A&M University, September 13-14, 1996. We have made every effort to assure faithful reproduction of Professor Miley's and Dr. Patterson's text in the limited time before that conference and ICCF6 in Japan. We wanted every ICCF6 participant—and those readers who could not be in Japan—to have the opportunity to examine this work. It has profound implications, at least as important as the discovery of nuclear fission fragments in the 1930s—probably much more so. It is remarkably careful work that leaves no doubt that the New Energy Age has begun. This preprint will *also* appear soon in the ***Journal of New Energy***, (edited by Hal Fox). This is a remarkable turning point in the history of cold fusion.—*Eugene Mallove, Jed Rothwell, and Chris Tinsley*

Preprint prepared for 2nd International Conference on Low Energy Nuclear Reactions, Texas A & M, College Station Texas, September 13-14, 1996.

NUCLEAR TRANSMUTATIONS IN THIN-FILM NICKEL COATINGS UNDERGOING ELECTROLYSIS

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ABSTRACT

Experiments using 1-mm plastic and glass microspheres coated with single and multilayers of thin films of various metals such as palladium and nickel, used in a packed-bed electrolytic cell (Patterson Power Cell Configuration), have apparently produced a variety of nuclear reaction products. The analysis of a run with 650-Å film of Ni is presented here. Following a two-week electrolytic run, the Ni film was found to contain Fe, Ag, Cu, Mg, and Cr, in concentrations exceeding 2 atom % each, plus a number of additional trace elements. These elements were at the most, only present in the initial film and the electrolyte plus other accessible cell components in much smaller amounts. That fact, combined with other data, such as deviations from natural isotope abundances, seemingly eliminates the alternate explanation of impurities concentrating in the film.

A 1-molar lithium sulfate solution in light water was employed for the electrolyte. A small excess heat of approximately 0.5 ± 0.4 watts was recorded throughout the run. Reaction products were analyzed using a combination of secondary ion mass spectrometry (SIMS), Auger electron spectrometry (AES), energy dispersive x-ray (EDX) analysis, and neutron activation analysis (NAA).

Results showing a broad array of products such as found here have also been obtained with thin film coatings of other materials, e.g., Pd and multi-layers of Pd and Ni. The yields of the major elements contributing depend on the film material, however. Some of that work is still being analyzed and will be presented at ICCF-6 (Miley and Patterson, 1996a).

The array of products found in these experiments is consistent with recent studies of solid Pd and Au electrodes by Mizuno et al., 1996 and Ohmori and Enyo, 1996, respectively. A distinct advantage of thin electrode construction used here, however, is that the reaction zone becomes well defined, enabling quantitative measurements of the amounts of various products.

To explain the observation of products with atomic numbers both well above and below Ni, a reaction model is being developed that involves proton-induced excited complexes, followed in some cases by a fission of the unstable compound nucleus

INTRODUCTION

Various nuclear transmutation products generated during electrolytic cell operation, typically employing Pd and heavy or light water with various electrolytes such as Na_2CO_3 and LiOH, have previously been reported, e.g., see the proceedings of the first conference in this series (Bockris and Lin, 1996). Most of these reports have dealt with impurity level quantities of specific elements, such as Sr, Rb or tritium, although some workers, such as Mizuno et al., 1996, Ohmori and Enyo, 1996, and Karabut et al., 1991 and 1992 report a wide variety of isotopes occurring at impurity levels. Several investigators, e.g., Miles and Bush, 1994, have concentrated on ^{4}He, which they view as a logical reaction product for nuclear reactions in solids.

While the occurrence of this number of independent observations strongly implies that chemically assisted nuclear reactions in solids are possible, the quantification and the credibility of the results have suffered from low, impurity-level yields and non-reproducibility. In sharp contrast, the thin (<2000Å) films used in present work result in transmutation of a significant percentage of the metal in the thin-film cathode due to the "small" number of host atoms. (While, as stressed later, impurity contributions can not be completely ruled out, the term "transmutation products" is used here due to the overwhelming evidence in favor of this identification.)

Over a dozen experiments with various types of thin-film coatings have been carried out in different cells (Miley and Patterson, 1996a). Thin-film coatings on 1mm-diameter plastic/glass microspheres, ranging from 500-Å-thick single layers of Pd or Ni to multiple Ni/Pd layers, were used in a flowing packed-bed-type electrolytic cell with a 1-molar Li_2SO_4 light water electrolyte. Nuclear reaction products were obtained in all cases, with several runs resulting in over 40 atomic % of the original coating materials being transmuted to reaction products such as Fe, Si, Mg, Cu, Cr, Zn, and Ag. The present paper deals with the specific case of a single

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nickel thin film, since it has been analyzed most thoroughly to date and appears to be representative of the behavior observed in the other runs.

The "normal" Patterson Power Cell employs electrolytically coated layers of Ni and Pd on microspheres, and this composition has been extensively studied for power production (Patterson 1996a). The Ni-coated thin film microspheres described here were developed explicitly for reaction product studies, although power production with "conventional" thick Ni electrodes in light water cells has been widely studied (e.g., see I. Myers et al. 1996 and references therein).

The use of thin-film coatings originates from the "swimming electron layer" (SEL) theory proposed earlier (Hora, Miley, et al., 1993; Miley et al, 1993; Miley et al., 1994), which suggests that nuclear reactions are assisted by the use of multilayer thin films with alternating metals that have large differences in Fermi energy levels. The resulting increase in electron density at the film interface is shown to "squeeze" excess electrons between ions, greatly reducing the Coulombic barrier, thus enhancing nuclear reactions. This theory was first studied using thin-film Pd/Ti coatings sputtered onto a large stainless steel substrate electrode (Miley et al., 1994). Those experiments were terminated due to flaking of the films off of the electrode soon after loading and heating occurred. However the results were very encouraging, since high excess heat (estimated to be kW/cm^3 at the interface regions) was observed for minutes prior to the disintegration of the thin films. Subsequently, J. Patterson (1996a) developed a unique electrode configuration using electrochemical deposition of relatively thick (mm) coatings of Ni/Pd layers on millimeter diameter cross-linked polymer microspheres. These microspheres were then employed in a flowing packed-bed-type electrolytic cell (Patterson Power Cell™). The coatings, while thicker than the earlier thin-film studies, were found to be quite stable in this configuration, so experiments with thin films (300- to 2000-Å thick) on such microspheres were undertaken in the present work.

The thin films were laid down using a special sputtering process (Miley, Narne, et al., 1996), where the microspheres are suspended in a fluidized state during the spraying process. The metallurgy of the films themselves has been studied before and after electrolysis, using both Auger electron probe techniques and electron microscopic surface analysis.

Reaction product measurements have utilized a combination of secondary ion mass spectrometry (SIMS), Energy Dispersive x-ray (EDX) analysis, Auger Electron Spectroscopy (AES), and neutron activation analysis (NAA). SIMS is used to obtain a broad view of both high and low concentration isotopes present and their isotopic ratios, while NAA provides a quantitative measure of the masses of key elements. EDX provides confirmatory data for elements having high concentrations, while AES is used for depth-profiling of high concentration elements. NAA can obtain total quantities of elements in a sample typically containing 10 microspheres, while the other techniques are restricted to probing a local area on single microspheres. Due to variations among microspheres due to location in the packed bed and other effects, this difference in samples becomes very important in present work. The analysis techniques and the nuclear reaction products observed are described further in following sections

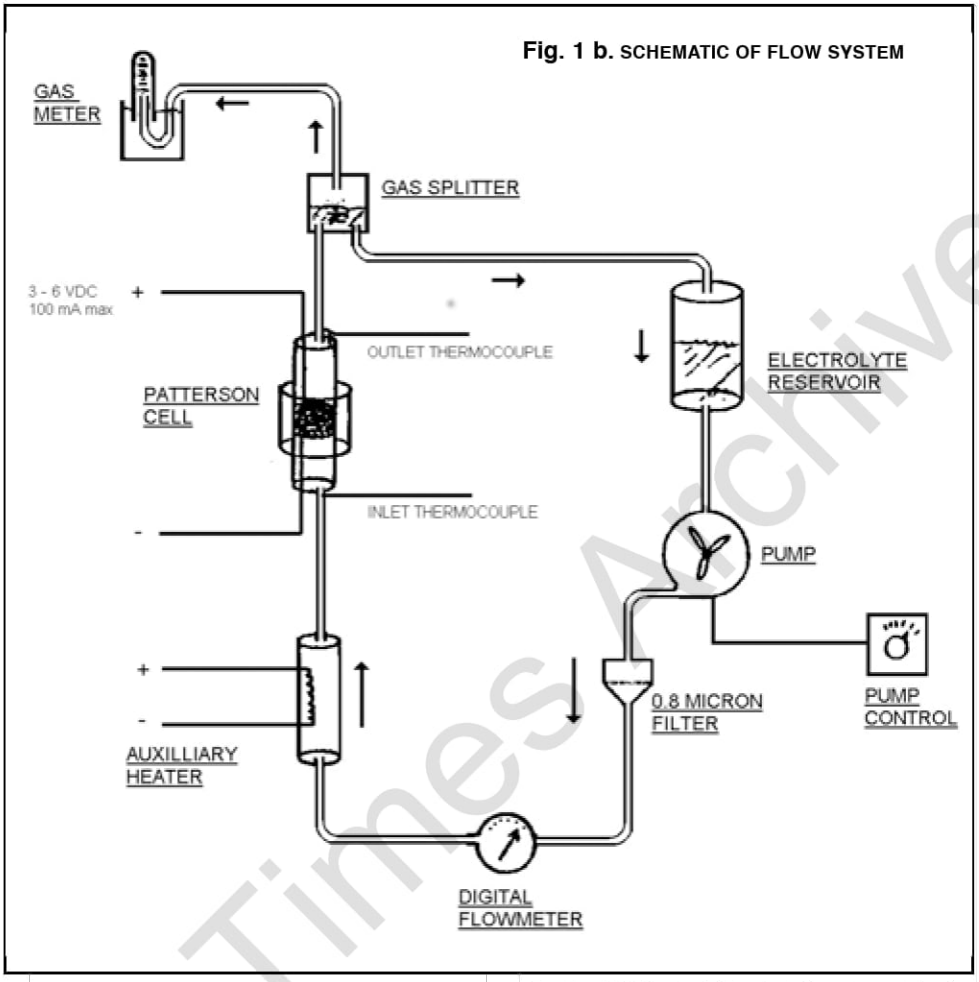

Fig. 1 b. SCHEMATIC OF FLOW SYSTEM

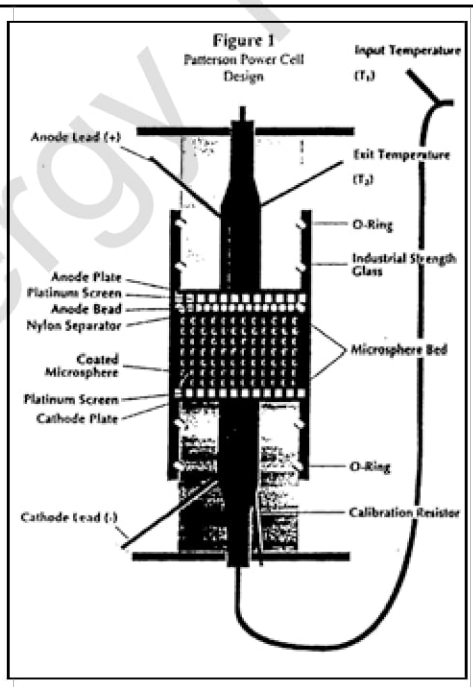

Fig. 1a. SCHEMATIC DIAGRAM OF A PATTERSON CELL

ELECTROLYTIC CELL DESCRIPTION AND OPERATION

The general configuration of the Patterson-type electrolytic cell employed is shown in Fig. 1a. About 1000 microspheres (~0.5 cm^3 volume) were used in the packed-bed cell. Titanium electrodes were employed in the present Ni run and in most other runs, except for a few cases where Pt electrodes were used for comparison purposes.

A flow diagram is shown in Fig. 1b. A preheater allowed control of the temperature of the electrolyte entering the cell from 20-70°C, with flow rates of ~11 ml/min. Voltages across the bed were held at ~2-3

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V, with several mA of current, giving an electrical input power of approximately 0.06 W. The pump and preheater consume an additional 5 W, but this input does not enter into the energy balance across the cell; hence the 5 W is not involved in the computation of excess heat production. Inlet-outlet thermocouples provide a measure of the temperature increase of the flowing electrolyte typical values ranged from 0.1 to 4°C, corresponding to about 0.1 to 4 W output, depending on the films used. Positive outputs were observed in all cases, but due to the calorimeter technique, the values are only considered to be accurate to ±0.4 W. More precise calorimetry is in use in several laboratories studying excess power from the Patterson cell, but here the cell design was focused on ease of reaction product measurement. In view of the positive results reported here, further work with improved calorimetry and periodic sampling of microspheres during runs is warranted to obtain a quantitative relation between the power (or energy production/run) and the various reaction products.

Such studies are now in progress. Still, the present reaction product data provides a first insight into this important new field of chemically-assisted nuclear reactions using thin-film electrolysis.

Loading of hydrogen into the thin film is typically done at low (25°C) temperatures and requires several hours, as observed by an initial increase in the voltage across the bed, i.e., the change in film resistance, followed by an eventual equilibrium voltage level of +2-3V. The loading time, defined as the time to reach this equilibrium state, was about an hour for the present Ni run. Thus this loading time was negligible compared to the two-week run time. A quantitative measurement of the loading was not attempted, although there is strong evidence presented by others that loadings in excess of 0.85 atoms of hydrogen or deuterium (H/D) per atom Pd are required in conventional solid Pd electrodes to produce heat (Crouch-Baker et al., 1995). After an equilibrium was achieved, the cell inlet temperature was raised slowly (over several hours) to the desired operating temperature of 60-70°C.

Further details about the construction and operation of this type of cell is given in Patterson, 1996a; Cravens, 1996; and Nix et al. 1996).

NICKEL-FILM RUN

The run lasted for 310 hours and employed an entering electrolyte temperature of approximately 60°C. Termination of the run was made prior to any noticeable deterioration of thermal performance. A temperature rise across the cell of less than 0.5°C was obtained throughout the run, representing an output of 0.5 ±0.4 watts. Calibration corrections due to heat losses and flow-pattern variations prevented a more accurate measurement, but the output always indicated a positive excess heat.

The cell employed for the run used all plastic fittings with the exception of the pressure and flow meters and the pump. (To further decrease possible impurity sources, a loop with all plastic components except for the electrodes was developed for subsequent runs. As noted later, this modification did not cause a noticeable change in film products.) Titanium electrodes were used. A filter fitted with 0.8-μm pore size filter paper was inserted in the loop to collect any fine particles entering the electrolyte, either from film surfaces or from other parts of the system.

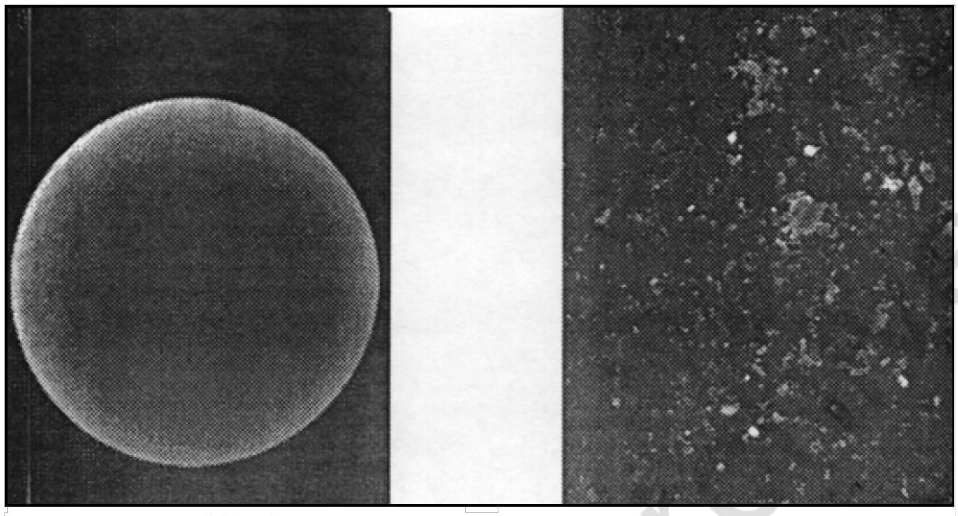

Fig. 2a. SEM photographs of the microsphere before a run (80X magnification on left & 1000X magnification on right).

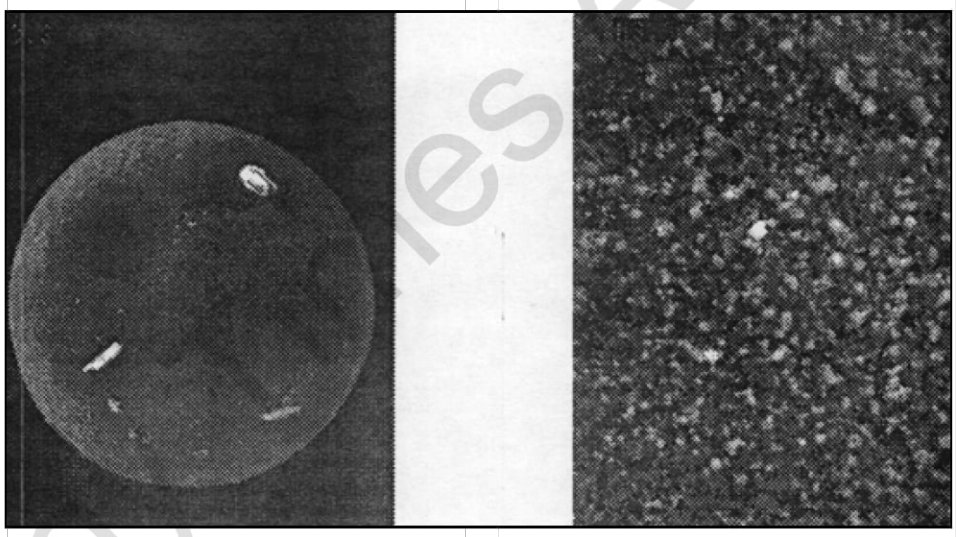

Fig. 2b. SEM photographs of the microsphere after a run (80X on left & 1000X on right).

Data for nickel coated microspheres (#80)

Layer	Diameter (cm)	Volume (cc)	Mass of layer (g)	# of atoms
PS	1.06E-01	6.22E-04	6.09E-04	
Ni(650A)	1.06E-01	2.29E-07	2.04E-06	2.09E+16

Table 1

Total Mass of a microsphere (g)	6.11E-04
Total Mass of metal on a microsphere (g)	2.04E-06
Total Atoms of metal	2.09E+16

Characteristics of the 650-Å Ni film microspheres used in this run (#8) are summarized in Table 1. A 650Å-thick Ni film was laid down by sputtering the Ni on to a 1-mm plastic core. The thickness of the layer was determined by weighing a calibration sample coated under the same conditions as the microspheres in the sputtering unit. Some coating variations, estimated to be ±30%, can occur among the 1000 microspheres used in the cell, however. Measurements with an Auger electron probe on select microspheres confirmed the film thickness to be reasonably uniform (±20%).

The mass of the metallic film on these

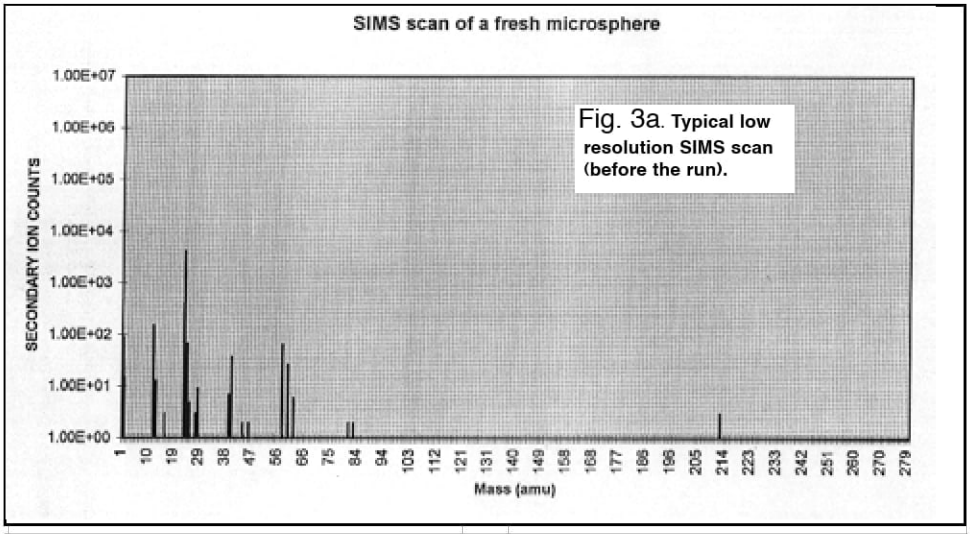

Fig. 3a. **Typical low resolution SIMS scan (before the run).**

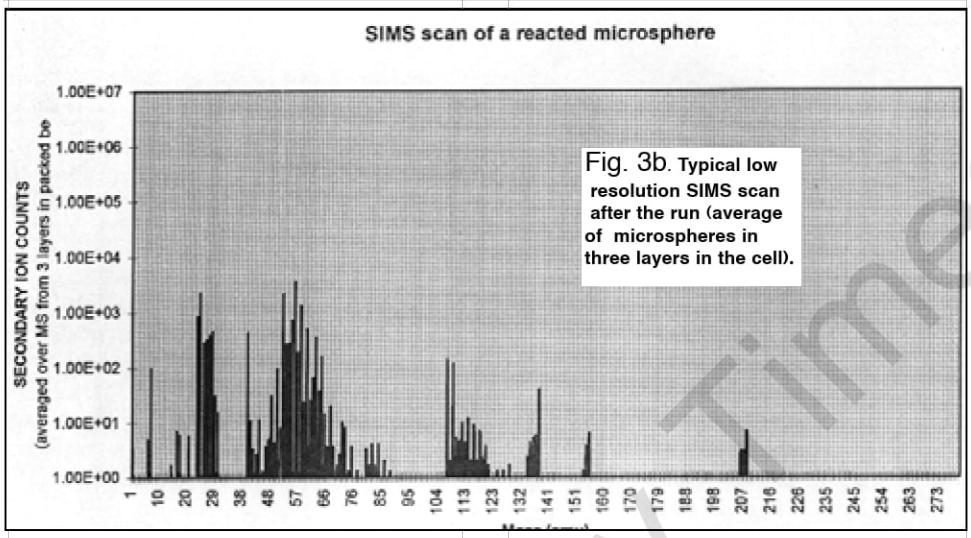

Fig. 3b. **Typical low resolution SIMS scan after the run (average of microspheres in three layers in the cell).**

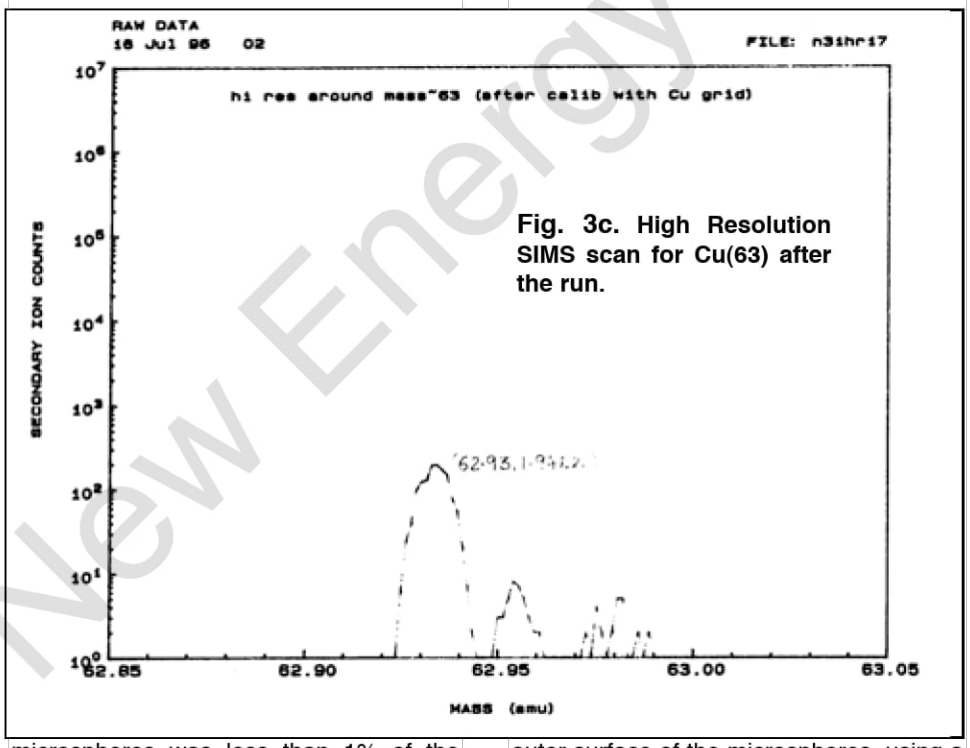

Fig. 3c. High Resolution SIMS scan for Cu(63) after the run.

microspheres was less than 1% of the total microsphere mass (see Table 1), giving a most unique electrode configuration for the electrolytic cell. Photographs of the outer surface of the microspheres, using a scanning electron microscope (SEM), confirmed that a very smooth surface was achieved with the sputtering process (Fig. 2a), while a high magnification photo shows a small-scale, rough structure uniformly distributed over the surface. Some erosion of small particles from the surface occurs during operation, however, as detected by placing a filter with 0.8-μm filter paper in the flow loop. Concurrently, various fragile looking bead-like and fiber-like structures are typically visible on the film surface after electrolysis, e.g., see Fig. 2b.

REACTION PRODUCT ANALYSIS METHODS

SIMS, EDX, AES and NAA methods were employed to analyze the microspheres before and after the run. Sampling was done by disassembling the cell after a run and removing microspheres from the top (cathode end) layer of the packed bed. (The 1000 microspheres in the bed result in roughly 3-5 layers total). These microspheres were selected for reasons of accessibility and the fact that the higher electric field in that region is expected to make this layer most reactive.

This limited selection procedure raises key issues about the reactivity in other layers. Thus, an uncertainty arises when it is desired to extrapolate the results to predict total cell characteristics (element yields or cell power). To study these effects in more detail, a new sampling technique employing a small plastic tube that is plunged into the bed to extract a "core sample" of microspheres has now been developed.

The SIMS analysis employed a Cameca IMS 5F unit operating with 8-keV oxygen primary beam in the positive ion mode (Wilson et al., 1989). Scans of key isotopes were made using single microspheres in a low-resolution (2,000 mass resolution) mode at several depths of interest (typically near the surface and interfaces) (see Fig. 3a). High-resolution (40,000 mass resolution) scans were then done to resolve any interferences involving important isotopes (e.g., see Cu-63 and Ag-107 in Fig. 3c,d). Although the SIMS gives the relative amounts of isotopes for a given element is accurately, the variation of isotopes with depth and the lack of reference samples for calibration of the SIMS sensitivity made it difficult to determine absolute concentrations of isotopes with this technique alone. Thus NAA was used to determine total concentrations of Al, Cu, Mg, Cr, Fe, Zn, V, and Ag (subsequently termed "***NAA elements***") in the microspheres. This data was, in turn, used as a calibration for the SIMS sensitivity to find concentrations of the other **"non-NAA"** elements, as described next.

Interpretation of the SIMS count data of Fig. 3 requires a knowledge of sensitivities (RSF values) for sputtering of each isotope

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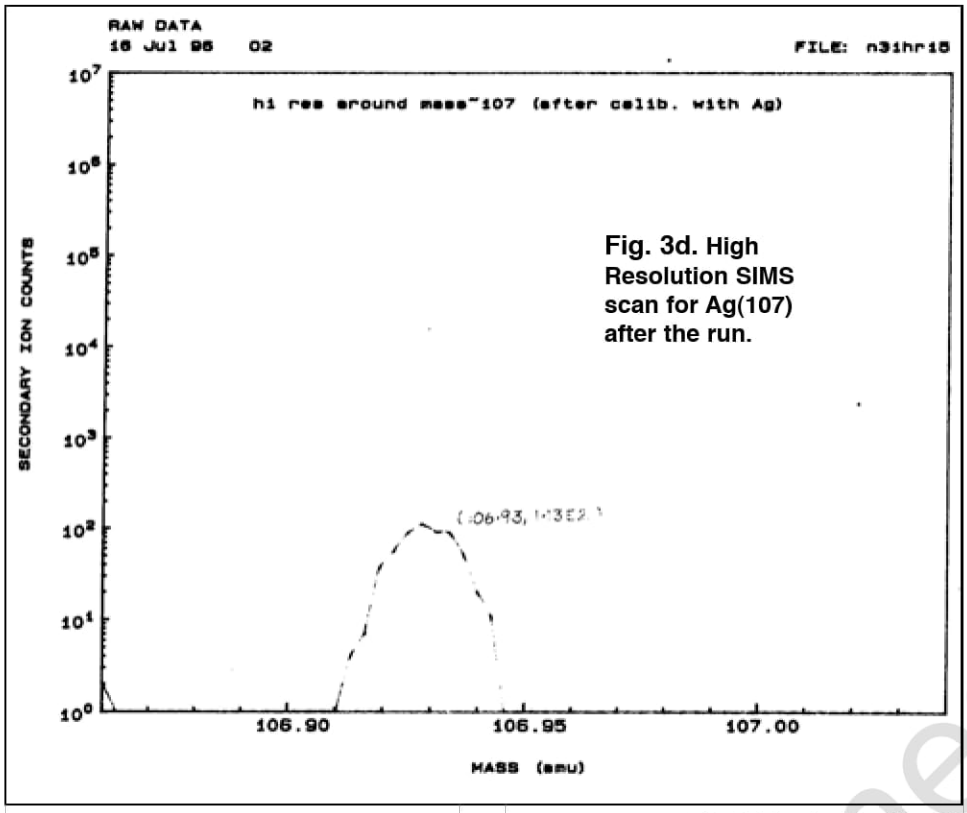

Fig. 3d. High Resolution SIMS scan for Ag(107) after the run.

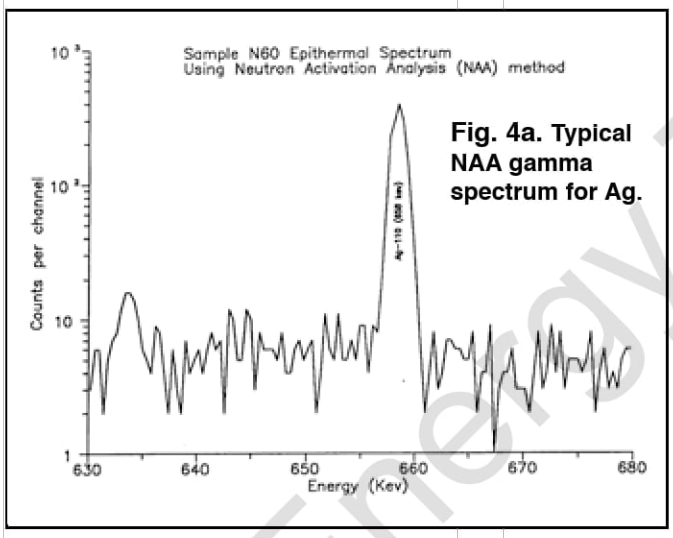

Fig. 4a. Typical NAA gamma spectrum for Ag.

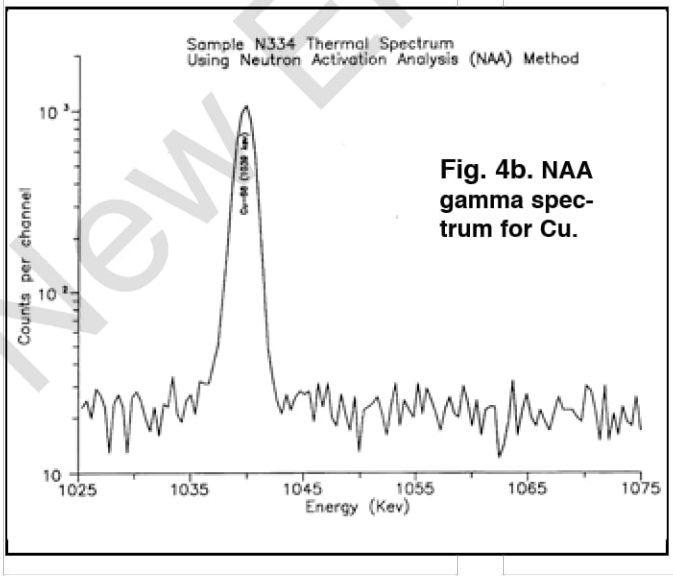

Fig. 4b. NAA gamma spectrum for Cu.

out of the host matrix by the SIMS's primary beam (Wilson et al., 1989)

For accurate analysis, the RSF should be determined by implanting a known quantity of the isotope of interest in a sample of the host matrix and measuring the RSF in the SIMS under the actual conditions employed. Since such a calibration is not available for thin film Ni, an alternate technique was employed. Theoretically (Wilson, et al., 1989), the RSF is an exponential function of the ionization potential (IP) for non-gaseous isotopes in a fixed host matrix. This functional relation was employed, but a RSF-IP slope from Ni matrix studies by Wilson and Stevie (1996, 1991), and Wilson, (1996) was assumed and fit through data for the nine NAA elements to obtain an RSF value for the remaining SIMS values. One refinement found necessary was to separate elements into two groups, one having concentrations >0.1% and one <0.1%, each group having a different RSF functional fit. (SIMS intensities tend to saturate at high concentrations.) With this technique, an uncertainty factor of 2 is estimated for the absolute values for non-NAA element percentages. (Note: due to changes in the RSF correlation employed, results presented here differ somewhat for those in an earlier draft of this paper, cf. G. Miley and J. Patterson, 1996c).

NAA was carried out at the University of Illinois (UI) TRIGA research reactor (Landsberger, 1996). Samples consisted of 10 microspheres. Techniques for short-lived NAA (Parry, 1991) were initially performed to determine the presence of Ag, Cu, Al, and V in the electrodes. (Subsequently, analysis of Fe, Cr and Zn was done in a similar fashion.) Epithermal NAA was used for Ag in conjunction with the $^{109}Ag(n,\gamma)^{110}Ag^{m}$ reaction using the 657.1-keV gamma ray. A 10-sec irradiation time at a flux of 2.1×10^{11} n/cm^2.sec, with a 20-sec decay time and a 75-sec counting time was used, along with a pneumatic transfer facility. Typical detection limits for Ag were of the order of 2 ppm, with a precision of ±10-15%. A typical gamma spectrum for the Ag analysis is shown in Fig 4a.

Thermal NAA was also used for Cu, Al, and V in conjunction with $^{65}Cu(n,\gamma)^{66}Cu$, $^{27}Al(n,\gamma)^{28}Al$, and $^{51}V(n,\gamma)^{52}V$, using the 1039.1-keV, 1778.9-keV, and the 1434.2-keV decay gamma rays, respectively. A representative gamma spectrum for Cu-66 is shown in Fig. 4b. Typically, a 2-min irradiation time with a flux of 4×10^{11} n/cm^2.sec, followed by a 2-3-min decay time and a 5-min counting time was used with the same pneumatic transfer facility. Detection limits were several ppm for Cu and less than 1 ppm for V and Al, with a precision of several percent for these elements. Calibration used certified liquid standards from the National Institute of Standards and Technology. Ores containing known quantities of these elements were analyzed for quality control. All such NAA results agreed within the error limits of the reference materials.

As a supplement to SIMS analysis, NAA was also employed to study key isotope ratios for comparison to natural abundance. Cu and Ag are of particular interest in the present work. Then, for example, an NAA measurement of the Cu63/65 ratio was carried out. Cu-63 was determined using the $^{63}Cu(n,\gamma)^{64}Cu$ reaction with the resulting 511-keV gamma ray to determine Cu-63. Cu-65 was determined using the $^{65}Cu(n,\gamma)^{66}Cu$ reaction using the 1039-keV gamma ray (see Fig. 4b).

The EDX analysis used a Field Emission Electron Microscope (Hitachi S800) operating in the energy dispersion analysis

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mode with the electron energy set at 20 kV to detect elements with atomic concentrations above about 1%. LINK software was utilized to derive the elemental concentrations from the energy spectrum. Due to the unique geometry with the curved film-plastic interface, the measurement accuracy was limited to 10%.

AES was used in a sputtering mode to perform semi-quantitative depth profiling for the major element species above 1 atom %. Two instruments were employed, PHI models 660 and 595, providing a resolution of approximately 25 nm. Depth profiles were also run with the SIMS, but the higher sputtering rates for SIMS greatly limited the spatial resolution in the thin film.

RESULTS

ELEMENT AND ISOTOPE CONCENTRATIONS

Results from NAA and EDX analysis of high concentration elements (Mg, Al, Si, Ag, Cr, Fe, Zn, and Cu) in the Ni run are summarized and compared in Table 2.

TYPE	NAA	EDX	EDX
Sample #	N3.3	N3.3	N3.3
Mg	NA	5.6	5.0
Al	0.51	2.3	2.2
Si	NA	7.3	6.1
S	NA	1.1	NL
Ag	6.61	17.0	30.7
Cr	5.94	6.9	6.5
Fe	14.53	17.2	10.3
Ni**	62.31	32.3	29.0
Cu	7.96	10.3	10.2
V	0.01	NL	NL
Co	0.10	NL	NL
Zn	2.04	NL	NL
Total	100.0	100.0	100.0

** microspheres taken from same location in the packed bed.*
*** Ni % (from NAA) adjusted for a total of 100%*
NA: Not included in analysis
NL: Percentage below detection limit

Table 2 – Comparison of NAA and EDX analyses for several microspheres. ANALYSIS COMPARISON (Atomic %)*

(Two NAA runs on the microspheres yielded values within 10% of those shown for NAA in the table). The variation in the concentrations observed is attributed to the fact that each analysis used a different sampling of microspheres taken from various locations in the packed bed at the end of the run. Some differences are expected from microsphere to microsphere due to variations in location and coating. Further, the NAA results provide total concentrations for a sample of 10 microspheres, while EDX examined only a small volume of an individual microsphere. Still, the important point is that these independent measurements confirm that following a run, over 40 atom % of the film consists of these product elements, the remainder being the host Ni plus trace elements.

To evaluate the other major **non-NAA** elements present and to obtain isotopic concentrations, SIMS and NAA data have been combined in Table 3. **NAA elements** are listed in bold. (Light elements, still under study, and other isotopes not observed are omitted from Table 3.) This table shows the yield, i.e., the difference between the final and initial weight for each isotope (fourth column). NAA only measured the elemental (isotopic) concentrations; therefore the NAA values for a given element have been pro-rated between isotopes according to the SIMS isotopic analysis. Corresponding values for the number of atoms of each isotope before ("fresh MS") and after ("reacted MS") a run follow in the fifth and sixth columns. Non-NAA elements used the SIMS data directly for both the element yield and the isotope values, based on the RSF interpretation discussed earlier.

Despite the uncertainties associated with the RSF correlation for non-NAA elements, the values shown in Table 3 should still provide a first estimate of **non-NAA** isotopes in the film. Note that the isotopic yields for **NAA elements** should be quite accurate, since the RSF values are essentially constant for isotopes of a given element, while the total concentrations of these elements come directly from the NAA measurement, avoiding RSF issues.

The isotopic atomic percents in the metal film are then calculated from the increased number of atoms for each element (column 7) and tabulated in the column labeled "SIMS." Comparison of this result with natural abundance values ("Natural a/o" in column 3) gives the "difference in a/o" shown in the final column. This data in Table 3 is used later to obtain figures for element production rates (Figs. 7 and 8), element yields (Figs. 9a and 9b), and isotope shifts (Fig. 11) vs. mass or Z. The systematics of the data will become clearer when these figures are discussed.

ELEMENT DEPTH PROFILES

Data from AES profile measurements on a typical microsphere are presented in Fig. 5 for the higher concentration elements.

Fig. 5. Tabulated atomic % vs. depth from AES scan.

Approximate Depth (Å)	0	100	700	2000
	Relative Atomic %			
C	20.00	-	-	61.23
Ag	2.68	9.94	11.77	3.07
Fe	7.72	10.02	10.45	5.12
Ni	9.99	12.30	22.28	12.56
Cu	4.17	7.64	7.61	5.38
Zn	11.12	10.48	9.22	-
Mg	10.78	13.75	-	-
Cr	-	-	3.66	4.99

While the isotopes' profile behaviors are hard to interpret quantitatively, several observations can be made. Most profiles peak in the nickel volume or near the film-plastic interface, suggesting an internal source rather than diffusion in from the surface. For example, the key elements Ag and Fe peak near the Ni-plastic interface, (at 650Å corresponding to about 12 min. sputtering time). Cu peaks further out in the film. However the amplitude of the peaks is too small to draw definitive conclusions about diffusion vs. an internal source.

The product concentrations decrease into the plastic substrate. However, the decrease is gradual, indicating strong interdiffusion has occurred under run conditions. This interdiffusion of products can explain some differences between NAA and EDX values noted earlier in Table 2, since NAA, in contrast to EDX, measures total amounts of elements throughout both the film and the core of the microsphere. This distinction also applies to NAA vs. SIMS measurements.

Fig. 5. Tabulated atomic % vs. depth from AES scan.

NUCLEAR RADIATION EMISSION

In view of the evidence that products are formed at a significant rate (order of 10^{15} reactions/s-cm^3, cf. Table 5, discussed later) in an operating cell, measurable radiation emission would normally be expected, assuming normal nuclear reactions. However, attempts to date to measure nuclear radiation emission-neutrons, gammas, or x-rays-during cell operation have

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Table 3. Yield Data from the Combined SIMS/NAA Analysis

Table 3

Data sheet for change in isotope atom % in metal film after run; comparison to natural abundance (Data from SIMS; isotopes in "bold" use NAA element weight)

Mass No.	Element	Natural a/o	Change (Reacted-Fresh) (in micro-grams)	Fresh MS Atoms	Reacted MS Atoms	Difference % Metal (atomic)	SIMS a/o	Difference in a/o (SIMS-Natural)
28	Si	0.92	1.02E-01	8.14E+16	3.02E+17	1.29E+00	4.67E-01	-45.46
29	Si	0.05	9.80E-03	0.00E+00	2.04E+16	9.79E-01	3.55E-01	30.81
30	Si	0.03	5.07E-03	0.00E+00	1.02E+16	4.89E-01	1.78E-01	14.66
32	S	0.95	9.54E-03	0.00E+00	1.80E+16	8.63E-01	1.00E+00	5.00
45	Sc	1.00	4.45E-05	0.00E+00	5.96E+13	2.87E-03	1.00E+00	0.00
46	Ti	0.08	2.00E-04	0.00E+00	2.62E+14	1.26E-02	4.98E-02	-2.95
47	Ti	0.07	2.79E-04	0.00E+00	3.58E+14	1.72E-02	6.79E-02	-0.49
49	Ti	0.06	2.52E-04	0.00E+00	3.10E+14	1.49E-02	5.88E-02	0.37
50	Ti	0.05	3.60E-03	0.00E+00	4.34E+15	2.08E-01	8.24E-01	77.01
50	**V**	**0.00**	**5.52E-07**	**3.54E+10**	**7.01E+11**	**2.79E-05**	**2.45E-03**	**0.00**
51	**V**	**1.00**	**2.30E-04**	**1.44E+13**	**2.86E+14**	**1.14E-02**	**9.98E-01**	**-0.04**
52	**Cr**	**0.84**	**9.22E-02**	**5.63E+14**	**1.07E+17**	**5.07E+00**	**8.70E-01**	**3.21**
53	**Cr**	**0.10**	**1.19E-02**	**6.27E+13**	**1.36E+16**	**6.42E-01**	**1.10E-01**	**1.51**
54	**Cr**	**0.02**	**2.27E-03**	**1.53E+13**	**2.55E+15**	**1.20E-01**	**2.06E-02**	**-0.30**
54	**Fe**	**0.06**	**1.34E-02**	**2.82E+15**	**1.78E+16**	**3.96E-01**	**5.72E-02**	**-0.10**
55	Mn	1.00	7.30E-02	0.00E+00	8.00E+16	3.85E+00	1.00E+00	0.00
56	**Fe**	**0.92**	**2.11E-01**	**4.29E+16**	**2.70E+17**	**6.01E+00**	**8.69E-01**	**-4.82**
57	**Fe**	**0.02**	**1.24E-02**	**1.01E+15**	**1.41E+16**	**5.14E-01**	**7.42E-02**	**5.23**
59	**Co**	**1.00**	**1.83E-03**	**1.23E+14**	**1.99E+15**	**7.58E-02**	**1.00E+00**	**0.00**
63	**Cu**	**0.69**	**1.17E-01**	**3.57E+15**	**1.16E+17**	**4.99E+00**	**7.00E-01**	**0.80**
64	**Zn**	**0.49**	**1.63E-02**	**1.42E+15**	**1.67E+16**	**5.74E-01**	**3.64E-01**	**-12.47**
65	**Cu**	**0.31**	**5.19E-02**	**1.54E+15**	**4.97E+16**	**2.14E+00**	**3.00E-01**	**-0.80**
66	**Zn**	**0.28**	**9.24E-03**	**7.82E+14**	**9.22E+15**	**3.16E-01**	**2.01E-01**	**-7.72**
67	**Zn**	**0.04**	**2.28E-03**	**1.14E+14**	**2.16E+15**	**8.55E-02**	**5.43E-02**	**1.32**
68	**Zn**	**0.19**	**1.41E-02**	**5.08E+14**	**1.30E+16**	**5.42E-01**	**3.44E-01**	**15.84**
69	Ga	0.60	7.59E-05	0.00E+00	6.64E+13	3.19E-03	5.50E-01	-5.40
70	**Zn**	**0.01**	**1.42E-03**	**1.64E+13**	**1.24E+15**	**5.70E-02**	**3.62E-02**	**3.00**
71	Ga	0.40	6.39E-05	0.00E+00	5.43E+13	2.61E-03	4.50E-01	5.40
72	Ge	0.27	5.39E-03	0.00E+00	4.51E+15	2.17E-01	4.84E-01	21.04
73	Ge	0.08	4.23E-03	0.00E+00	3.49E+15	1.68E-01	3.75E-01	29.74
74	Ge	0.37	8.94E-04	0.00E+00	7.28E+14	3.50E-02	7.81E-02	-28.69
75	As	1.00	4.89E-02	0.00E+00	3.93E+16	1.89E+00	1.00E+00	0.00
76	Ge	0.08	7.34E-04	0.00E+00	5.82E+14	2.80E-02	6.25E-02	-1.51
76	Se	0.09	1.63E-02	0.00E+00	1.29E+16	6.21E-01	1.29E-01	3.88
77	Se	0.08	1.65E-02	0.00E+00	1.29E+16	6.21E-01	1.29E-01	5.32
80	Se	0.50	4.29E-02	0.00E+00	3.23E+16	1.55E+00	3.23E-01	-17.54
82	Se	0.09	5.71E-02	0.00E+00	4.20E+16	2.02E+00	4.19E-01	32.75
85	Pb	0.72	4.03E-07	0.00E+00	2.86E+11	1.37E-05	5.00E-01	-22.20
87	Pb	0.28	4.12E-07	0.00E+00	2.86E+11	1.37E-05	5.00E-01	22.20
87	Sr	0.07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-7.02
88	Sr	0.83	2.13E-05	0.00E+00	1.46E+13	7.01E-04	1.00E+00	17.40

mas, or x-rays-during cell operation have not detected any measurable quantities above background. A ^{3}He detector was employed for neutron measurements, and a cooled NaI crystal detector was used for gammas and x-rays. In one run, a 5-mm-thick Be window was placed over a small hole drilled into the side of the cell to allow measurement of softer x-rays (estimated lower limit of 20 kV), but after a four-hour run, none were detected. It is planned to repeat these measurements in a shielded area to reduce the background; however, if radiation emissions are escaping the cell, they are very low in intensity.

Another measurement used a liquid-scintillation detector to search for tritium in a sample of electrolyte immediately following a run. This measurement was repeated, and a sample was also sent out for independent analysis, but in no case was tritium detected. An experiment to measure the presence of tritium in the off gas, along with other possible products such as ^{4}He, is under consideration, but due to the very low concentrations involved, such measurements become very demanding.

Two attempts to measure beta or x-ray emission from the microspheres after a run were made by placing them on the face of a liquid N_2 cooled NaI crystal detector covered with a thin Be foil, but without positive results. Next, a set of microspheres was placed on medical x-ray film for a 3-day exposure--again negative results. Subsequently, a sample of microspheres run several months earlier were placed in a liquid scintillator and counted for three hours, using a Packard Tri-Carb 1500 dual-channel liquid-scintillation detector. No significant reading above background was obtained.

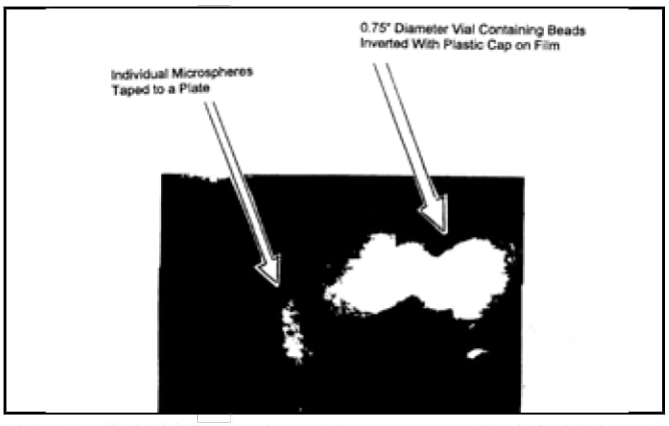

Fig. 6. Nickel Microsphere Exposure on Kodak ASA 3000 Polaroid Film.

Recently, several sets of microspheres (run about 4 months earlier) were exposed to high-speed ASA 3000 film for a 4-day period with positive results as shown in Fig. 6 (Klema, 1996). Unfortunately, these

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Table 3 (continued)

Mass No.	Element	Natural a/o	Change (Reacted-Fresh) (in micro-grams)	Fresh MS Atoms	Reacted MS Atoms	Difference % Metal (atomic)	SIMS a/o	Difference in a/o (SIMS-Natural)
89	Y	1.00	3.37E-05	0.00E+00	2.28E+13	1.10E-03	1.00E+00	0.00
93	Nb	1.00	8.13E-05	0.00E+00	5.27E+13	2.53E-03	1.00E+00	0.00
95	Mo	0.16	1.20E-04	0.00E+00	7.62E+13	3.66E-03	3.33E-01	17.63
96	Zr	0.03	7.85E-05	0.00E+00	4.93E+13	2.37E-03	1.00E+00	97.20
98	Mo	0.24	1.24E-04	0.00E+00	7.62E+13	3.66E-03	3.33E-01	9.53
100	Mo	0.10	1.26E-04	0.00E+00	7.62E+13	3.66E-03	3.33E-01	23.70
107	**Ag**	**0.52**	**1.22E-01**	**7.32E+15**	**7.61E+16**	**2.47E+00**	**5.70E-01**	**5.17**
108	Pd	0.27	3.27E-03	0.00E+00	1.83E+15	8.78E-02	2.73E-01	0.57
109	**Ag**	**0.48**	**9.90E-02**	**6.68E+15**	**6.14E+16**	**1.87E+00**	**4.30E-01**	**-5.17**
110	Pd	0.12	8.89E-03	0.00E+00	4.87E+15	2.34E-01	7.27E-01	60.93
111	Cd	0.13	2.33E-02	0.00E+00	1.27E+16	6.08E-01	1.12E-01	-1.60
112	Cd	0.24	5.38E-02	0.00E+00	2.89E+16	1.39E+00	2.56E-01	1.50
113	Cd	0.12	2.37E-02	0.00E+00	1.27E+16	6.08E-01	1.12E-01	-1.10
113	In	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	-4.28
114	Cd	0.29	6.33E-02	0.00E+00	3.35E+16	1.61E+00	2.96E-01	0.70
115	In	0.96	4.86E-05	0.00E+00	2.55E+13	1.22E-03	1.00E+00	4.30
116	Cd	0.08	4.87E-02	0.00E+00	2.53E+16	1.22E+00	2.24E-01	14.82
117	Sn	0.08	8.85E-04	0.00E+00	4.56E+14	2.19E-02	1.48E-01	7.20
118	Sn	0.24	2.45E-03	0.00E+00	1.25E+15	6.02E-02	4.07E-01	16.74
119	Sn	0.09	7.87E-04	0.00E+00	3.99E+14	1.92E-02	1.30E-01	4.38
120	Sn	0.33	1.47E-03	0.00E+00	7.41E+14	3.56E-02	2.41E-01	-8.73
121	Sb	0.57	5.05E-03	0.00E+00	2.52E+15	1.21E-01	1.00E+00	42.80
124	Sn	0.06	4.69E-04	0.00E+00	2.28E+14	1.10E-02	7.41E-02	1.47
125	Te	0.07	5.82E-03	0.00E+00	2.81E+15	1.35E-01	3.75E-01	30.51
126	Te	0.19	3.91E-03	0.00E+00	1.87E+15	8.99E-02	2.50E-01	6.30
128	Te	0.32	5.96E-03	0.00E+00	2.81E+15	1.35E-01	3.75E-01	5.70
135	Ba	0.07	5.39E-05	0.00E+00	2.41E+13	1.16E-03	9.26E-02	2.67
137	Ba	0.11	6.93E-05	0.00E+00	3.05E+13	1.47E-03	1.17E-01	0.43
138	Ba	0.72	4.71E-04	0.00E+00	2.06E+14	9.88E-03	7.90E-01	7.31
151	Eu	0.48	1.74E-05	0.00E+00	6.94E+12	3.34E-04	3.33E-01	-14.47
152	Sm	0.27	2.46E-05	0.00E+00	9.74E+12	4.68E-04	2.14E-01	-5.27
153	Eu	0.52	3.52E-05	0.00E+00	1.39E+13	6.67E-04	6.67E-01	14.47
154	Sm	0.23	9.12E-05	0.00E+00	3.57E+13	1.72E-03	7.86E-01	55.87
155	Gd	0.15	3.92E-04	0.00E+00	1.53E+14	7.33E-03	9.09E-01	76.21
156	Gd	0.21	3.95E-05	0.00E+00	1.53E+13	7.33E-04	9.09E-02	-11.41
163	Dy	0.25	2.90E-05	0.00E+00	1.07E+13	5.16E-04	1.00E+00	75.00
165	Ho	1.00	3.42E-05	0.00E+00	1.25E+13	6.00E-04	1.00E+00	0.00
172	Yb	0.22	5.24E-05	0.00E+00	1.83E+13	8.82E-04	1.00E+00	78.20
206	Pb	0.24	2.67E-03	0.00E+00	7.82E+14	3.76E-02	2.67E-01	3.07
207	Pb	0.23	2.69E-03	0.00E+00	7.82E+14	3.76E-02	2.67E-01	4.07
208	Pb	0.52	4.75E-03	0.00E+00	1.37E+15	6.57E-02	4.67E-01	-5.63

experiments are not yet reproducible. A second positive exposure has been obtained, but three additional attempts failed. The technique is under study, and if verified, will demonstrate emission of low-energy beta rays or soft x-rays (estimated to be of the order of 20 keV for the geometry of Fig. 6).

In summary, there is very preliminary evidence for soft x-ray (<20 keV) or beta emission from microspheres after operation. There is not an easily measurable emission of other high-energy radiation from the microspheres after operation or from the cell during operation. These facts must be considered when possible reaction mechanisms are sought to explain the present results. Much more study is needed, however, to fully define possible radiation emission for these cells.

MASS BALANCES AND IMPURITY ISSUES

The use of thin films introduces a problem in reaction product studies due to the small volume occupied by the film vs. the large volume of the electrolyte--about 100 cm^3 electrolyte vs. 3 x 10^{-4} cm^3 film for 1000 microspheres in the bed (cf. Table 1), a volume ratio of 10^5:1. The corresponding mass ratio is roughly the same; consequently a low ppm impurity in the electrolyte could, if concentrated in the film, give a very high ppm there.

Note that some of the key elements are present in trace (but measurable) quantities in the applied thin film; e.g., recall Table 3. However the initial values are typically a small fraction of the final, and they are always subtracted out in the analysis of the increase in concentration of an element used to report yields and production rates. Thus the key issue is whether there is another source of these isotopes in the cell or loop. Potential sources of impurities include the Li_2SO_4 itself, the cell glass, the insulating anode salt beads, the Ti (or Pt in some cases) electrodes, and other loop components. Those components which were easily accessible plus the electrolyte and filter paper were analyzed by NAA since higher precision is required than is possible using manufacturer's specifications for impurities.

Masses for representative key elements (Ag, Al, Cu and V) based on NAA analyses of the microspheres, the electrolyte, and the filter paper are summarized in Table 4a. The key potential source of impurities in the microsphere film is the electrolyte. However, as seen from the table, the ratio of total mass of the four key elements in the electrolyte to that in the thin film was < 10% for Ag, Cu, and V, but was comparable for Al. Thus, at least for the first three elements, impurities in the electrolyte could not possibly account for present observations.

Impurities on the filter paper itself are also negligible. The total impurity masses in the electrodes are larger, but most of it is not "accessible." For example, while the Ti electrode was 100 μg Cu, if it is assumed as much as 1% of the Ti in the anode was dissolved and deposited in the Ni film, the Cu would be only 1 μg, or 0.1% of the increased Cu found there. Examination of anode surfaces after the runs indicates no observable erosion. Further, if large erosion occurred, more Ti

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Table 4a.

Key element mass balances from NAA on microspheres, electrolyte and filter paper before and after a run

Microspheres

Element	ppm (fresh)	ppm (used)	Mass diff (g) / 1000MS
Ag	125.4	2594.9	1.51E-03
Al	11.2	50.2	2.38E-05
Cu	27.0	1840.9	1.11E-03
V	0.1	2.6	1.52E-06
Cr	2.9	1126.4	6.87E-04
Ni	1821.0	4420.5	1.59E-03
Fe	217.2	2956.6	1.67E-03
Zn	15.4	488.8	2.89E-04
Co	0.6	20.5	1.22E-05

used det. limit for ppm of Fe & Zn

Filter Paper

Element	ppm (fresh)	Mass in sample
Ag	0.0	8.79E-09
Al	0.9	7.07E-07
Cu	2.0	1.62E-06
V	0.0	7.79E-09

Filter Paper

S.No:	89.0
M(sample):	0.81

Electrolyte

Element	ppm (fresh)	Mass in system
Ag	0.03	3.00E-06
Al	2.2	2.20E-04
Cu	0.8	8.00E-05
V	0.01	9.00E-07

Electrolyte

S.No:	83.0
M(sample):	0.82
Initial Vol.(ml)	100.0
Times Filled	1.0
M(in system)	100.0

Electrode Material (Ti; two electrodes)

Element	ppm (fresh)	Mass in sample
Ag	1.3	1.15E-06
Al	84	7.46E-05
Cu	120	1.07E-04
V	215	1.91E-04

Ti electrode

S.No:	85.0
M(sample):	0.044
M(of electrode):	0.444
# of electrodes:	2.0
M(in system):	0.89

* all masses are expressed in grams
* M : abbreviation for Mass
* S. No. : abbreviation for Serial Number
* MS : abbreviation for Microsphere

Table 4.

Table 4b.

NAA result for sulfonated polystyrene microspheres

Element	ppm (before run)	ppm(after run)
Ag	0.7	2.9
Al	123.0	133.2
Cu	64.2	35.1
V	0.8	0.2

would be expected on the microsphere surfaces than was found. Thus, the 1% erosion assumed here is, if anything, a gross overestimate. For these reasons, the Ti anode cannot account for the observed elements in the Ni film, and the ppm of other elements in the electrode rule it out as their source also. Analyses of the plastic components and other fittings leads to a similar conclusion for them. In no case is the upper limit for the amount of accessible material in any system component (singularly or taken together) enough to account for the key element concentrations found in the microsphere films, Al being a notable exception.

Balances for the many other elements found in the film have not been carried out (other than for subtraction of initial amounts found in the film by NAA or SIMS prior to a run). Thus, there remains a concern that some may be associated with trace impurities. Still, a number of the products found are not nominally anticipated to be present in materials used in the experiment. Thus, the likelihood that the entire array could have this origin seems unlikely.

Several additional checks on possible component contamination were run. In one, special microspheres with a conducting surface created by sulfonation were run in the cell with a voltage-current applied to simulate a Ni run. Subsequent NAA analysis of the microspheres (see Table 4b) and the filter paper showed that no build up of the important elements occurred on them. In this case, if impurities were present from a loop component, larger changes in the element concentration on the sulfonated beads than seen in Table 4b would be expected. (Changes there lie within the accuracy limits for NAA and microsphere-to-microsphere variation.) In another run, the cell was filled with glass microspheres and run at elevated (~60°C) temperature but without an applied voltage. Again no impurity build up was found.

Additional strong evidence was obtained in more recent work where runs are done in a special "clean" cell where all plastic parts are used in the loop except for the electrodes. The electrolyte is further purified by pre-test runs. Results from operation with this new cell are still being analyzed, but preliminary results confirm that the elements reported here are still formed despite the further reduction of possible impurities.

There is additional extremely strong evidence that the reaction products are not from external source contamination. First, many of the products observed show shifts from isotopic ratios in natural elements (see Fig. 11, discussed later), uncharacteristic of normal impurities. Second, in the other runs (not presented here) many different elements are found, varying according to the material used for the thin film. If the source were elsewhere in the loop, the same elements would be expected, irrespective of the specific film material. Third, as discussed later, the yields of key elements appear to be consistent with independent results from different, but related experiments by Mizuno et al. (1996), and Ohmori and Enyo (1996). Such a coincidence seems unlikely if impurities were involved due to the differences in experimental set-ups.

A noteworthy point related to mass balances is that noticeable quantities of materials were collected on the filter paper during the run, but this material is attributed to particles breaking off of the film surface under operating conditions. A SEM photograph of the debris on the filter paper after the nickel run is shown in Fig. 7. A thin solid layer of cake-like material is visible, with larger flakes on top plus small droplets, both of which appear to come from the bead surface (cf Fig. 2). Additional evidence that this material came from the film is based on runs where conducting plastic or glass microspheres were employed and material paper on the filter did not collect, confirming that this material does not originate from the electrode, cell walls or other loop components. NAA shows a composition similar to the film. Thus if elements contained in these materials were included in the analysis as

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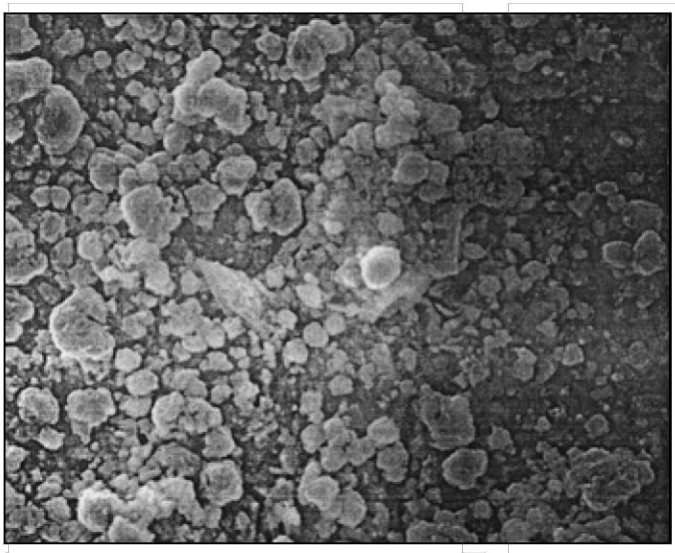

Fig. 7. SEM photograph of debris on filter paper.

belonging to the film, even larger yields would be reported.

In summary, the finding that the masses of the key isotopes are large compared to possible sources of such isotopes from loop components, the negative results from simulation runs without Ni films, the observation of isotope shifts from natural abundance, and the observation that the isotopes vary with film material, combine to provide very strong evidence that the products reported are due to nuclear reactions. The next issue is to consider what reactions can account for these observations.

REACTION PRODUCT SYSTEMATICS

PRODUCTION RATES

Based on the yield data presented earlier, time-averaged element production rates are computed in Table 5 and plotted in Figs. 8a and 8b in terms of weight fraction of the metal film/s-cm^3 of film and atoms/s-cm^3 of film, respectively. These figures assume that the production rate was constant over the 310 hour run. There is some preliminary indication that the rate is higher at the start, and the time dependence, along with the effect of microsphere location, is now under study.

As seen from Fig. 8a, the large yield elements Cr, Fe, Se, Cu, Cd, and Ag have weight fraction (μg of element per μg metal film at start of run) production rates exceeding 0.1/s-cm^3. This corresponds to a rate of roughly 10^{-4} μg/sec for the full 1000-microsphere cell, or a run total of roughly 1 mg/element. In terms of atoms produced, the high yield elements have rates of ~10^{16}/s-cm^3, suggesting a nuclear reaction rate of corresponding magnitude.

Then assuming these five elements dominate and are created at 10^{16}/s-cm^3 each, operation at 0.5 watts for the 1000-microsphere cell corresponds to an average energy release of roughly 6 x 10^{-2} MeV/atom reacting. Such an energy release is easily obtained by various exothermic nuclear reactions (Miley 1995), but as discussed later, due to the formation of heavy elements like Cu, Ag, and Cd, some endothermic reactions "absorb" energy. Thus the 0.5 W excess must be viewed as a "net" energy release from these various reactions.

The corresponding total increase in element masses, or in element atoms, are presented in Figs. 9a and b respectively. Consistent with the production rate graphs, these figures show total yields per microsphere approaching 0.1-0.2 μg per high yield element, or 3-6 atomic % in the metallic film.

It is interesting to compare these results to those reported by Mizuno et al., 1996, who ran a high-current-density Pd electrode in a cell at high pressure and temperature with a heavy water Li_2CO_3 electrolyte. They report a rich variety of reaction products at 1-mm depth, concentrated in groups with atomic numbers 6-8, 20-30, 46-54, and 72-82. While a one-per-one comparison is not possible since the present study used Ni rather than Pd, this distinct grouping of products is consistent with the present results where major products group between Z = 12-14, 20-30, and 46-56. The resemblance is seen from Fig. 10, where Mizuno et al.'s results are superimposed on the present data. Since Mizuno et al. did not report absolute yield values or rates, for comparison, their results have arbitrarily been normalized to the present Cu production rate. With this normalization, a number of the production rates for other high yield products agree reasonably well with Mizuno et al's. results, e.g., note from Fig. 10 that Si, Cr, Fe, and Cd lie close together. Larger variation in lower yield elements is observed where various elements are found in one experiment and not the other. Two noticeable differences, the high yield of gases (Xe and O) and the yields at high Z-72-82 group, including Os, Au, Hg found by Mizuno et al., might be anticipated. Gases are expected to diffuse out of the thin films used in present work, hence would not be found in SIMS results. The reduction of products in the 72-82 group in present experiments is probably associated with the use of the lower Z Ni host material (vs. Pd). In conclusion, the resemblance of certain key features of the present results and those of Mizuno et al. is striking.

The large production rate of Fe found here also has a resemblance to the observation by Ohmori and Enyo (1996) that notable amounts of Fe was formed in electrolytic cells with Au and Pd electrodes and various light water electrolytes. They report Fe yields of ~10^{16} atom/cm^2 (17μg and 38μg maximum from Au and Pd electrodes, respectively). The present Fe production rate of 5.4 x 10^{15} atoms/s-cm^3 (cf Figs. 8b or 10) corresponds to 5.9 x 10^{21} Fe atoms/cm^3-film. For the 650-Å film thickness, this is equivalent to about 3.8 x 10^{16} Fe atoms/cm^2, in reasonable agreement with Ohmori and Enyo's measurements. The yield of Fe in present work from Fig. 9a is ~0.22μg/microsphere, or ~0.2 mg total for the 1000 microsphere cell—about 10 times the Ohmori-Enyo yield. A major factor in the higher yield is probably the larger surface area (~32 cm^2) of the microspheres vs. the 5-cm^2 plates used by Ohmori-Enyo. Other factors, such as input power, electrolyte, etc. must also affect the results, but attempts to optimize cell conditions in these varied experiments seem to have resulted in amazingly similar Fe production rates.

ISOTOPE SHIFTS FROM NATURAL ABUNDANCE

Differences between the isotopic percentage concentrations observed with the SIMS vs. those for natural abundance for the reaction product elements, listed earlier in Table 3, are summarized in Fig. 11. The accuracy of these measurements is estimated to be of order of ±3% in the difference when high resolution is employed. High resolution was used to eliminate possible line overlap in all important cases, but with the large number of elements found, this was not possible for all of the lower yield isotopes. Thus, those results must be viewed as less certain. Of the higher concentration elements, Fe and Zn, show significant deviations. Cr and Ag are in the ±3-5% range, while Cu is in the ±1% range. Many low-concentration elements show quite large differences e.g., Ti-50, +77.7%; Ge-72, +21%; Se-82, +32%; Zr-96, +97%; etc. There are no obvious patterns, however.

To further study the deviation from natural abundance for the vital isotopes of Cu (Cu-63 and -65) and Ag (Ag-107 and -109) special NAA isotope measurements (described earlier) are underway. First results for the present Ni run, based on a sample of 10 microspheres, indicates a deviation from natural % abundance of +3.6 ± 1.6% for Cu-63 and -8.1 ± 3.6% for

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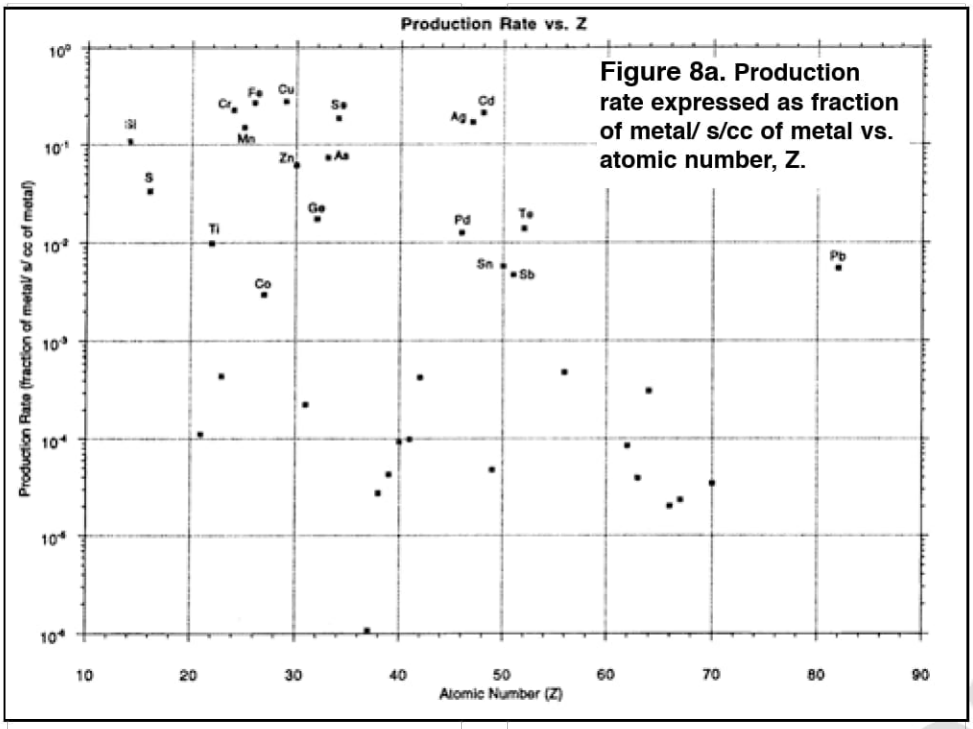

Figure 8a. Production rate expressed as fraction of metal/ s/cc of metal vs. atomic number, Z.

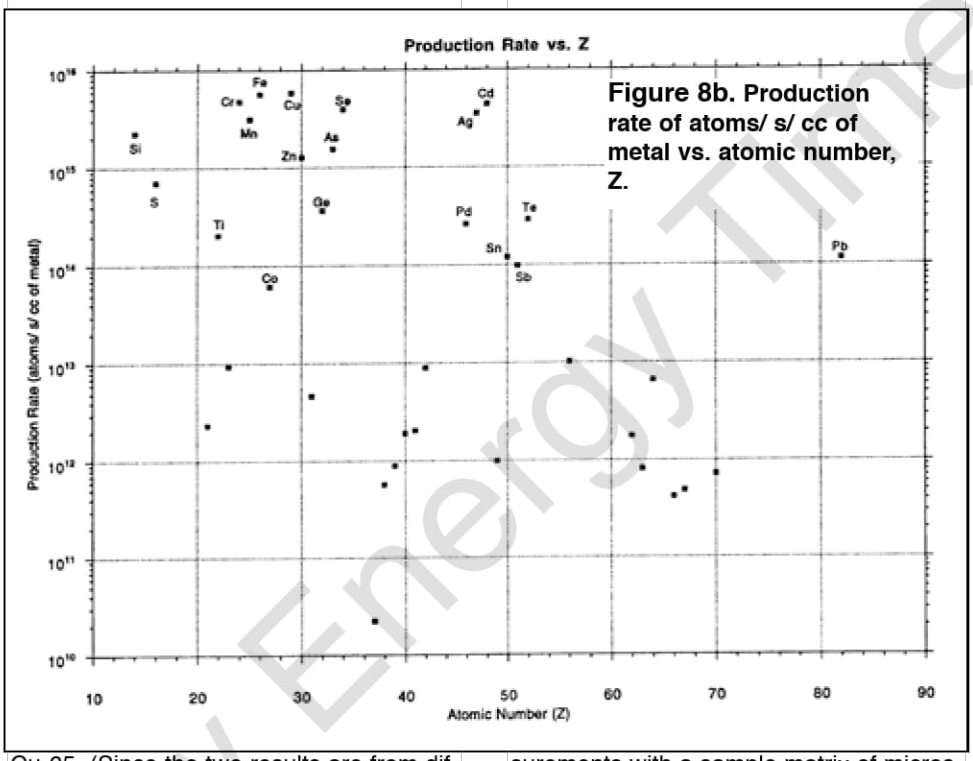

Figure 8b. Production rate of atoms/ s/ cc of metal vs. atomic number, Z.

Cu-65. (Since the two results are from different lines, unlike SIMS, slightly different values can occur in the + and - values for pairs.) These results are to be compared to a deviation of +0.8% for Cu-63 and -0.8% for Cu-65 from the SIMS data. The reason for larger percent differences with NAA than SIMS is not clear. A possible explanation is that as stressed earlier, the SIMS results are localized on a spot on a single bead film whereas the NAA value represents the ratio of total amounts of each isotope contained in films on the 10 microsphere sample. These issues are now under study employing multiple measurements with a sample matrix of microspheres.

The trend in the Cu shifts found here is similar, but smaller, than reported by Mizuno et al. (1996) who cite Cu-63, +25% and Cu-65, -25%. Shifts for Fe have been reported by Mizuno et al. and also by Ohmori and Enyo (1996), and are compared to present results in Table 6. While differences are observed, two isotopes, 56 and 57, do show the same trend for all cases.

While a more detailed comparison of the various shifts is not possible due to material differences, the observation of a large number of isotope shifts in Fig. 11 is consistent with the large number of deviations reported by Mizuno et al. They used this observation to argue that the elements observed were due to nuclear reactions, rather than impurities. The possibility exists for some isotope separation due to diffusion in the host metal, but that effect seems unlikely to account for the varied changes observed. In conclusion, Mizuno et al's isotope shift argument against impurity sources applies to the present results also, and, combined with the large product yields compared to possible impurity sources, strongly supports the nuclear reaction hypothesis.

REACTION MECHANISM CONSIDERATIONS

A nuclear explanation for the products observed here requires an entirely new theory for chemically assisted reactions in solids. Here it is possible only to point out some features that should be considered in such a theory.

As several workers have stressed (Miley et al., 1989; Preparata, 1991, Hagelstein, 1995), any theory for reactions in solids must explain: 1) how the reacting ions overcome the Coulombic barrier, and 2) what reactions take place after the ions interact. In the present case, the SEL theory cited earlier offers a possible explanation for overcoming the Coulombic barrier between ions in a thin-film electrode. While only a single film was used in the Ni run, a Fermi level difference can develop at the plastic/film interface or at any oxidized region on the outer surface. More work, is needed to obtain definitive evidence for the validity of this theory, however. And even if SEL theory is accepted, the key issue of what reactions occur after barrier penetration remains open.

In view of the large yields obtained, the reactants must involve some of the key species present, namely: Li, S, or O from the electrolyte; C and H from the plastic microsphere core; Ni from the thin films (cathode); and protons (p) from the light water. The isotope yield profiles do not indicate that elements from the electrolyte participated in the transmutations. Further, unpublished results (J. Patterson, 1996b), indicate that operation with a Na-based electrolyte (vs. Li) results in similar heating rates. Carbon from the plastic can not be ruled out, but is viewed as an unlikely participant. For these reasons, the following assumes that the main reactions involve p-Ni interactions, with protons possibly coming from the plastic core as well as the electrolyte.

The concept that excess heat from electrolytic cells originates from reactions involving the electrode material, e.g. Pd

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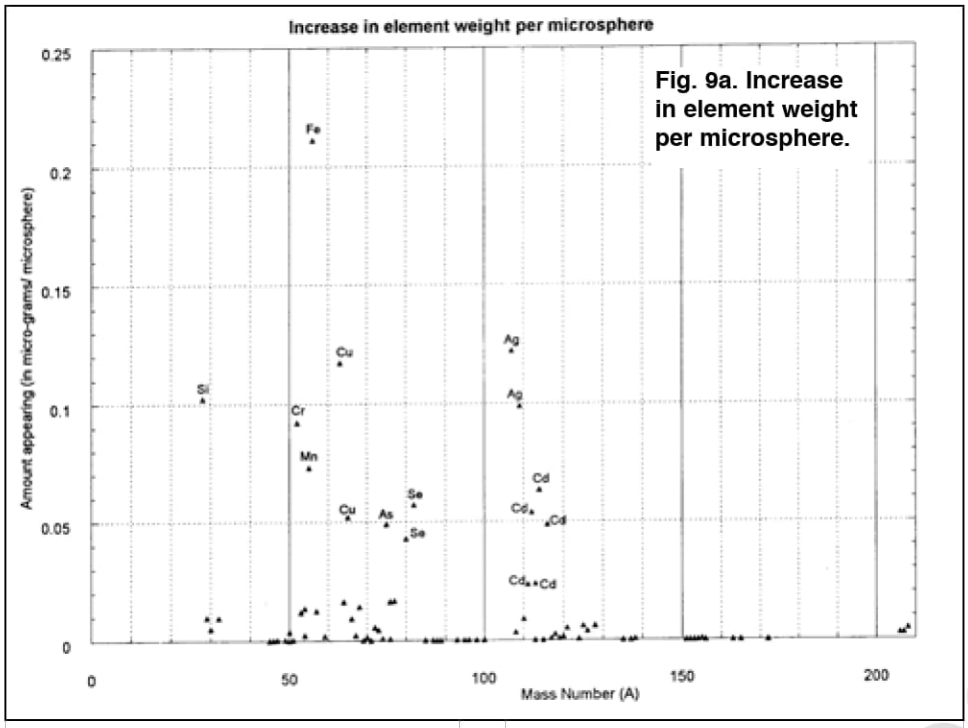

Fig. 9a. Increase in element weight per microsphere.

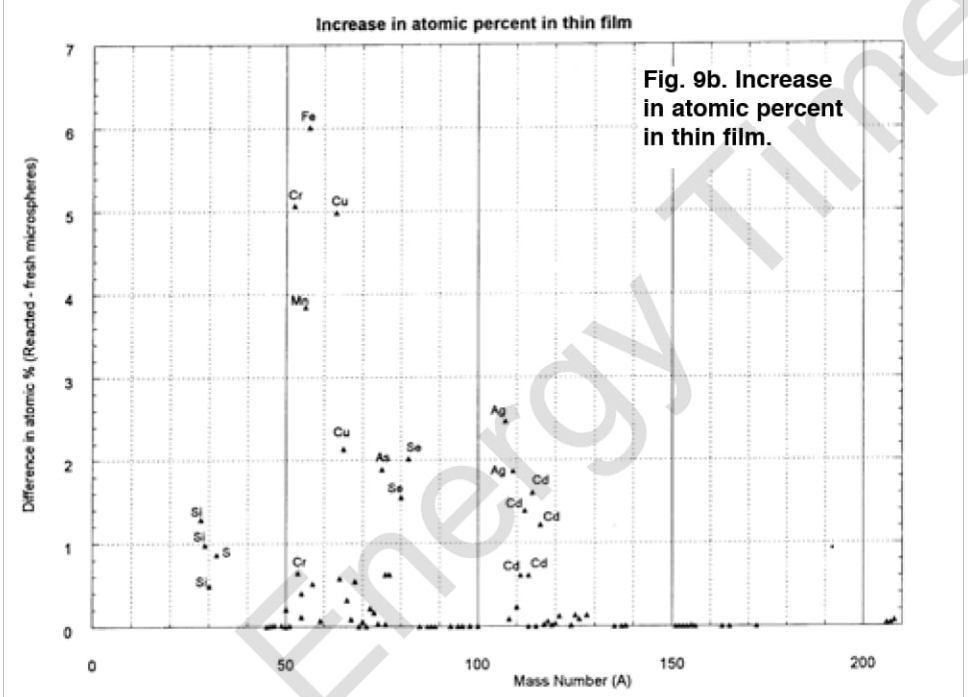

Fig. 9b. Increase in atomic percent in thin film.

electrode, is not new. Indeed, Ragheb and Miley, 1989, originally proposed that in a heavy water cell, Oppenheimer-Phillips-type neutron-stripping reactions between the D and Pd might explain early observations. Later, Miley (Appendix B in Hoffman, 1995) summarized the status of such theories, and ironically introduced a table of possible p-Pd reactions (including examples of fission-type reactions). The present Ni results add a new dimension to these thoughts, however.

The present data provides information on a number of characteristics that any successful model must explain. Most importantly, the model must predict the large yields of the high-concentration elements, without introducing added products not observed. This fact alone rules out many possibilities, e.g., a simple p-Ni reaction followed by a succession of p reactions with products, plus fission of some elements (cf the multi-D Pd chain proposed by Mizuno, et al. [1996] to explain their Pd-heavy water results) fails this test.

In this respect, one aspect of present data noted earlier, is that gaseous products can diffuse out of the thin films. Thus, theoretical models with gaseous products, e.g., He, Xe, and Kr, should not be ruled out based on present data.

Other key features observed in Figs. 8 and 9 that must be accounted for by any theory include the "gaps" between high yield products and the high Ag and Cd yields. Ag (and Cd) production is particularly challenging, since Ag occurs in large quantities but is not favored energetically. Ag's position, well to the lower binding energy side of Ni, infers an endothermic reaction (-Q value), which in turn suggests energy transfer to the reactants must occur to drive the reaction. (This is analogous to driving -Q value reactions by colliding high-energy reactants using accelerated beams. As defined here, Q values are the energy released due to the mass difference between reactants and products, assuming that the reactants enter with zero kinetic or excitation energy.) Consequently, the model must contain a mechanism for energy storage/transfer to reactions involved in high Z element production.

A postulated reaction model, RIFEX (Reaction in a Film-Excited CompleX), is under development to satisfy these key characteristics. A major feature of RIFEX is that protons (p) interacting with the host Ni and neighboring isotopes produces a relatively long lived atom-p complex with excitation energies of orders of several MeV. This allows production of elements such as Ag with -Q reactions. Other products are produced by +Q reactions via fission of compound nuclei. This model will be presented in detail in a future publication.

CONCLUSIONS

The results presented here defy conventional views in many ways. First, chemically-assisted nuclear reactions are not widely accepted by the scientific community. The present results not only confront that disbelief, but add a new dimension to the issue by reporting copious light and heavy element reaction products that seem to imply multi-body reactions due to the formation of heavier elements such as Cu and Ag from Ni. Further, a reaction which does not emit intense high-energy gammas is required by the experimental results. All of these features are difficult to comprehend and at first glance seem to point to impurities. However, as stressed, an extensive effort to find an impurity source has not uncovered one. Also, there is other strong evidence (such as isotope shifts, the different products occurring when the coating material is changed, and the similarity in yield trends with results from other workers), which supports the conclusion that the elements observed are reaction products.

Fortunately, cell experiments of this type are relatively straightforward and inexpensive. Thus far, reaction products, such as reported here, have been detected by the

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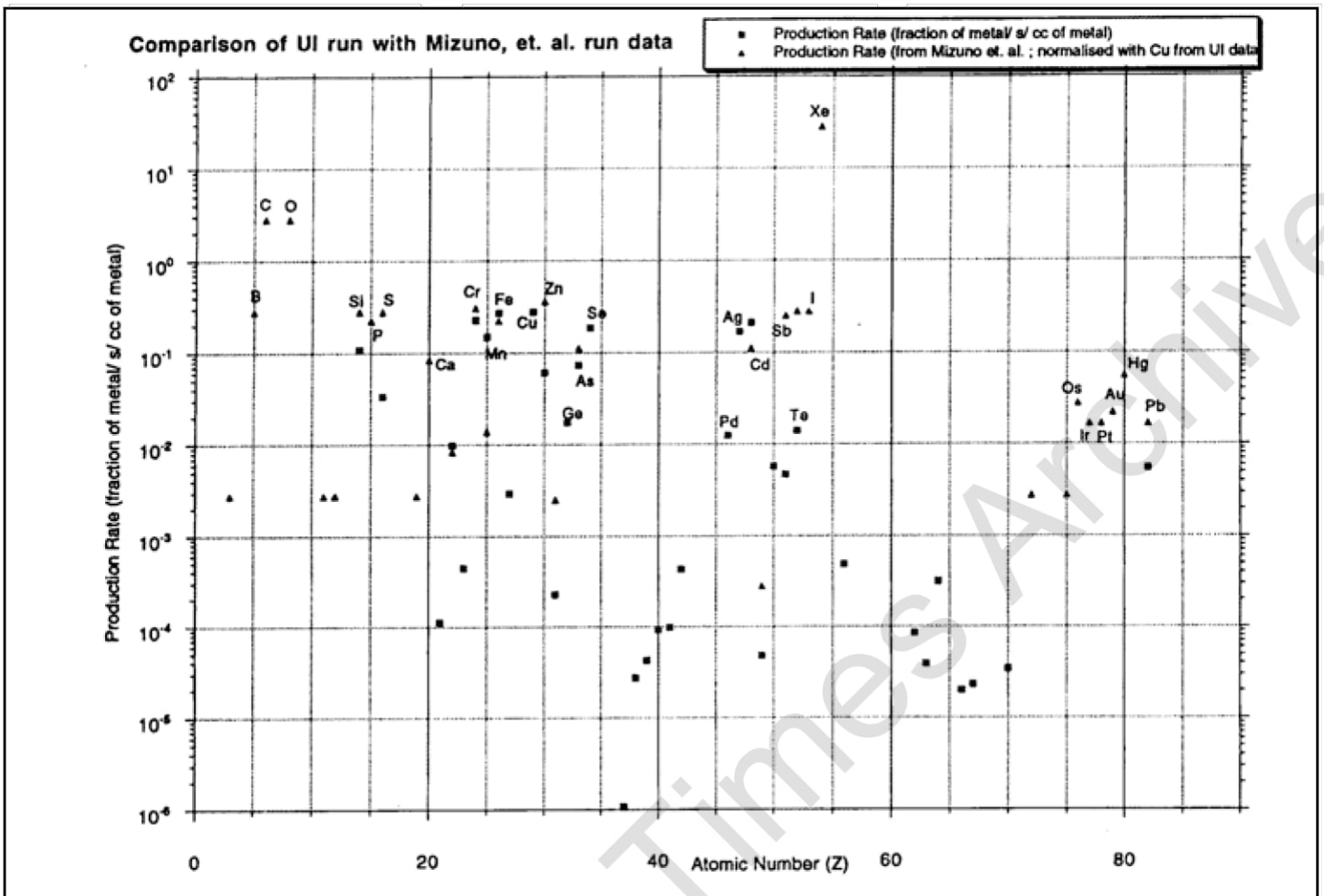

Fig. 10. Comparison of present production rate data with Mizuno et al.

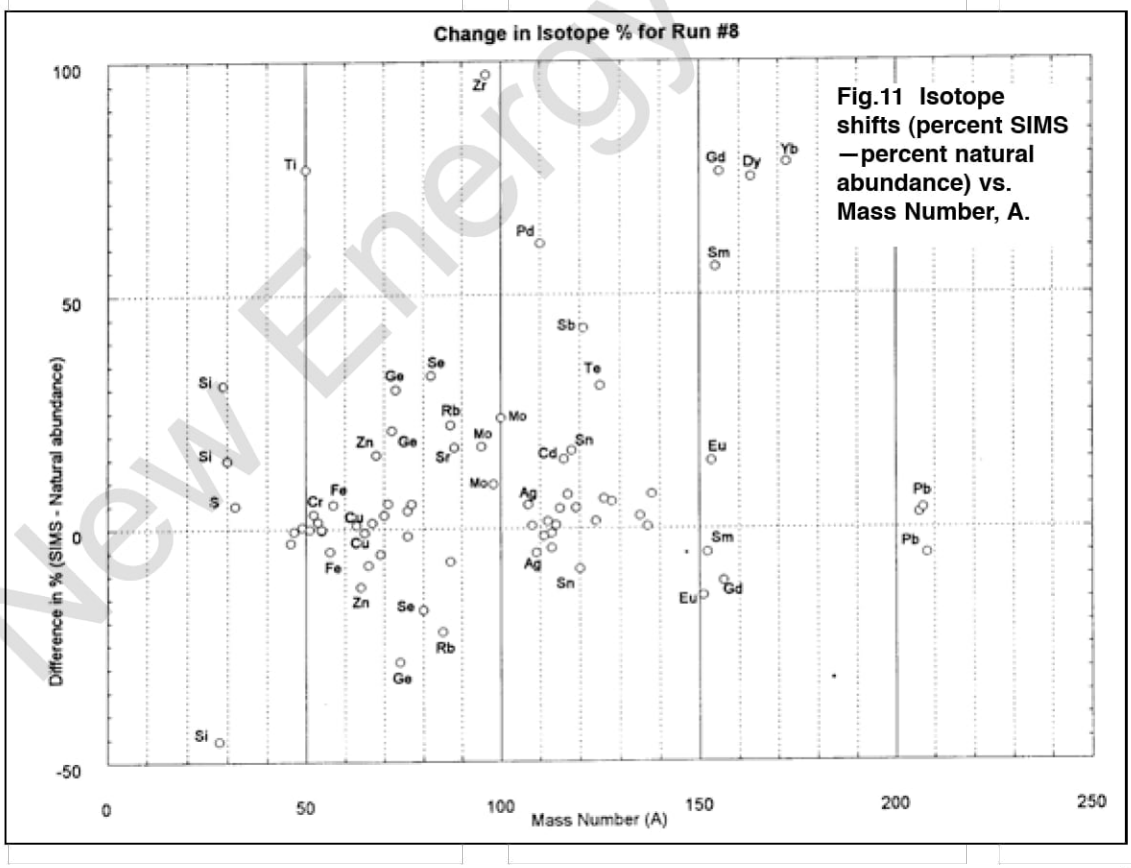

Fig.11 Isotope shifts (percent SIMS —percent natural abundance) vs. Mass Number, A.

authors in all dozen experiments of this type performed, using a variety of metallic films. In this sense, the phenomenon seems highly reproducible. The use of thin films as developed here offers a way to simplify the analysis since a large fraction of the film contains the new elements and their localization in the film allows a qualitative determination. Hopefully, open-minded scientists will attempt to replicate the experiments to convince themselves. If verified, the thin-film approach to chemically assisted nuclear reactions opens the way to a whole new field of science.

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ACKNOWLEDGMENTS

This work was supported by a grant from CETI. The authors wish to acknowledge essential contributions to this effort by a number of individuals. G. Narne carried out experiments at the UI and assisted in both SIMS and NAA measurements. M. Williams (UI) was responsible for microsphere coating and for cell mechanics, and he coordinated microsphere analysis. J. Baker and staff at the Center for Microanalysis of Materials, UI, supervised the SIMS analysis and consulted on its interpretation. S. Landsberger (UI) carried out the NAA analysis and provided important insight into its interpretation. D. Cravens (CETI) was instrumental in the cell design, in helping with numerous problems that arose during operation. J. Reding (CETI) helped coordinate the UI and CETI efforts and has provided most valuable encouragement and enthusiasm. R. Twardock (UI), carried out independent radiation measurements on the microspheres. E. Klema (Tufts U) carried out film exposures on the microspheres and provided valuable insights. H. Hora (UNSW) consulted on SEL and other theoretical aspects. Valuable comments on an earlier draft, by M. McKubre (SRI) and P. Hagelstein (MIT) are also gratefully acknowledged.

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THE CORREA PAGD REACTOR: Errata and Supplement

by Mike Carrell

Introduction

Issue 8 of *Infinite Energy* contained an overview of the Correa invention, based on three issued US patents and discussions with Dr. Correa The readership of *Infinite Energy* includes subscribers to an Internet listserver called Vortex-l, constituting an informal discussion group for the range of topics included in *Infinite Energy*.

The group includes many professionals in a variety of disciplines, who accept the possibility of new energy phenomena, but vigilantly examine each new device or process The author is indebted to members of Vortex-l for pointing out some errors in the previous article and areas where more data and clarification is needed. In particular, Dr. Mitchell Swartz found errors by the author in Fig. 4 of the previous article, and showed a need for clarifying some points concerning Fig. 5.

The author is indebted also to Mark Hugo, Bob Horst, Michael Schaeffer and others for a spirited discussion The following material is the responsibility of the author, and carries no implied endorsement by Dr. Swartz, Dr. Correa, or others.

Errata, Fig. 4, p. 11, *IE* #8

The three curves and scales are faithful copies of original data provided by the Correas. The author made three errors in supplemental calculations done for the convenience of readers.

In Issue #8 Fig. 4a, the "Delivered charge (from the Drive Pack)" should be 0.008 amp-sec = 0.008 coulomb. The "Received Charge"" (by the Charge Pack) should be 1.2 amp-sec = 1.2 coulomb. Corrected numbers now appear in the adjacent Figure 1. *The charge out/in ratio is 150.*

In Issue #8 Fig. 4c, the "Charge Pack Input" energy should be 445 joules. Again, corrected numbers now appear in the adjacent Figure 1. *The energy out/in ratio is 101.* This ratio is not the same as the charge ratio because the DP delivers its charge from a source at 570V and the CP receives its charge as a sink at about 380V.

Batteries as Energy Integrators

Fig. 5 of the previous article and its related text outlined a procedure used by the Correas to integrate the energy input and energy output of the reactor to test the performance of various reactor configurations. There are many uncertainties in using lead-acid batteries for this purpose, but the gel-cell construction used for the Correa tests is recognized by the industry as being the most stable, repeatable form of the lead-acid battery. Fig. 5 is a graphical illustration of the procedure used, but certain points were left unclear.

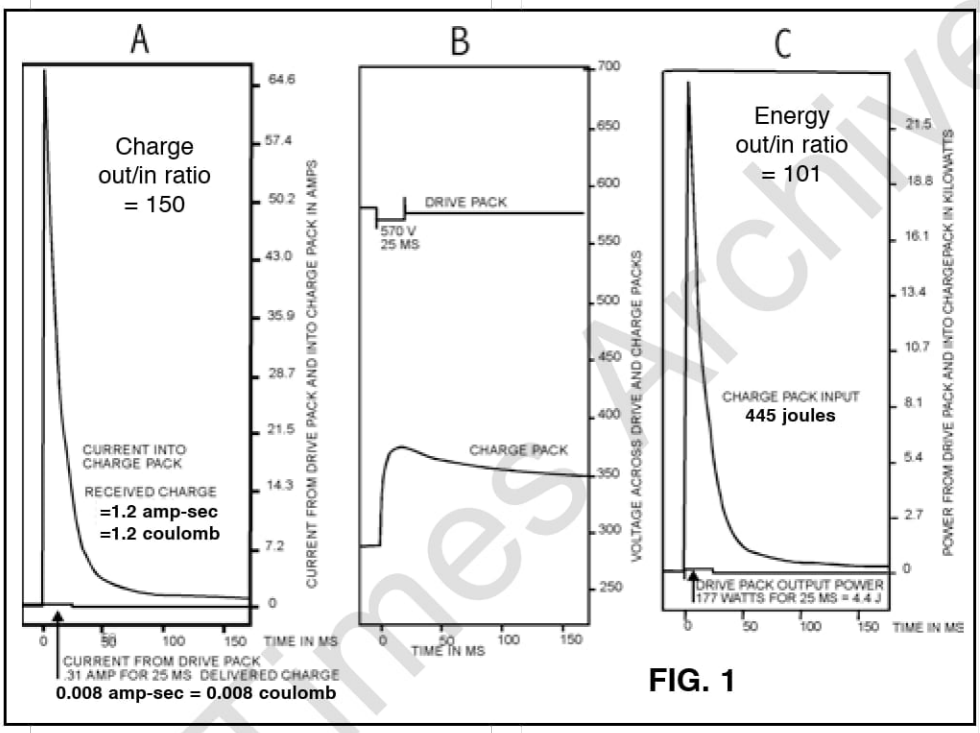

FIG. 1

Before each PAGD run, the DP and CP batteries are each calibrabd by fully charging, then discharging through fixed resistors, with the battery output power measured at frequent intervals and recorded in graphical form.

Just before a PAGD run, the batteries are again charged and partially discharged, using the same load resistors as before. This is, in effect, a new partial calibration. The PAGD run is then performed. In the case of Fig. 5, the run was 70 minutes. Any apparent differences are due to the different scale factors and slight errors in constructing the plots.

After the PAGD run, the batteries are again connected to their resistive loads and the discharge continued, with power measured at frequent intervals.

The discharge data taken just before the PAGD run can then be mapped against the data taken in the previous complete calibration to establish the state of charge of each battery. There is no requirement that the preliminary discharge times be the same; in the case of Fig 5, the DP is discharged for about 100 minutes and the CP for about 220 minutes. It is only necessary that enough points be taken to compare with the previous calibration curve to establish confidence in the estimation of the charge state of the battery.

The discharge power data for each battery taken after the run is mapped against the previous calibration curves to establish the new charge state of the batteries. Again, it is not necessary to discharge each battery fully, only to obtain enough points that the mapping can be done with confidence. In each case the batteries were discharged for over an hour.

With all these precautions, the calculation of energy out/in is sensitive to errors involving differences of large numbers, such as the determination of the 6 Wh energy loss of the DP. Table 8, p. 38 of *IE* #7 contains summaries of six runs using different reactor configurations. The energy out/in ratios range from 4 to 34. OIF these, the run illustrated in Fig 5. has the least energy spent and the greatest gained, and the greatest sensitivity to measurement errors. But all show substantial over-unity performance.

The four curves in Fig. 5 of the previous article *all deal with one experiment*, although features of the several curves could make it seem that unrelated measurements are grouped together. In partic-

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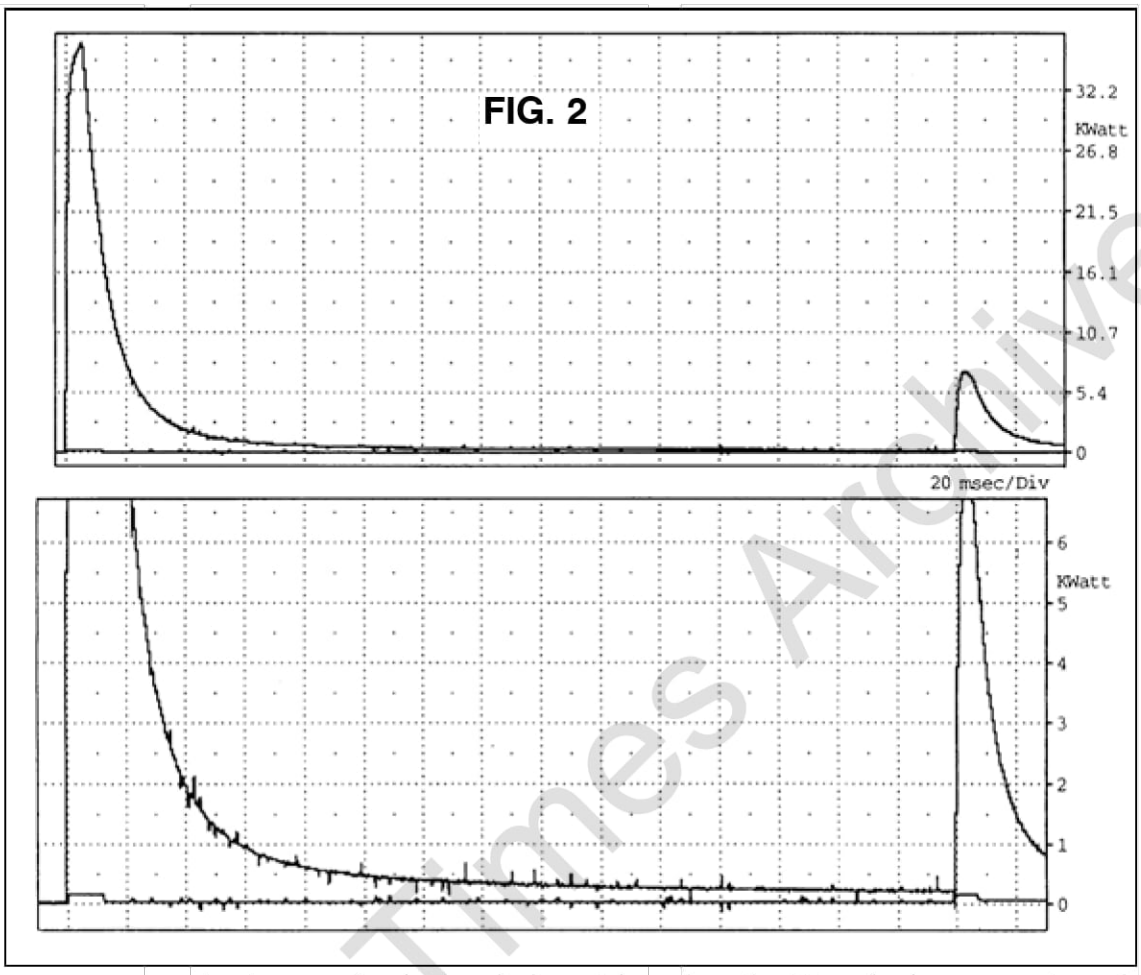
ular the two curves at the right depict the separate calibrations performed before and after the PAGD runs, as noted above. The time scales are intended to indicate proportionate durations of the elements of the calibrations and runs, not clock time. The two battery packs have their own histories of charge and discharge, which are coincident in clock time only during the PAGD run. The rest times are indicated as a minuimum of 15 minutes, as dictated by good practice, but there is no definite maximum time, which is unrecorded and unrepresented in the graphs.



Closed Loop Tests

A crucial test of o/u claims is the capability to operate the device without external or stored (battery) power input, while still producing tangible work.

The previous article described a test the Correas performed using two reactors and two center-tapped batteries, illustrated schematically in Fig. 7 of that article. Numerical data from the test is not publicly available, but Dr. Correa told the author that it was run for eight hours, with the batteries switched hourly by operation of a single switch. During this time, both batteries gained energy, as measured by power into a load resistor.

Why Batteries?

Many observers express dissatisfaction with batteries as integrators in quantitative measurements. The author has discussed this with Dr. Correa on many occasions. One answer emerged from early tests with the characterization tests described below. When the PAGD event occurs, a very powerful burst of energy is released within the reactor space and more than one electrical power supply and regulator have been burned out. Batteries are rugged sources of energy.

Relaxation Oscillator?

When claims are made for a new phenomenon, particularly in the search for o/u performance, it is proper to first search for a conventional explanation for the effects seen.

Some readers have noted a similarity between the test circuit shown as Fig. 3 of the previous article, and the well-known discharge tube relaxation oscillator. In this circuit, a capacitor shunts a discharge tube and is charged through a series resistor. When the capacitor charges to the tube's breakdown voltage, the accumulated energy is discharged through the tube. Repeated powerful flashes, as in a strobe lamp, result.

In this case, the energy is first stored in the capacitors, then released in the discharge tube. The test circuit shown as Fig. 3 of the previous article bears a superficial similarity to a relaxation oscillator, but it does not operate as such nor does the PAGD phenomenon depend on it.

Evidence Against "Relaxation Oscillator"

The evidence is three-fold. First is a brief recapitulation of the analysis in the previous article. Second is a discussion of two oscillograms provided by the Correas, not included in the previous article. Third is a review of the extensive characterization of the PAGD phenomenon in circuits which are clearly not relaxation oscillators.

Refer now to the analysis in the previous issue. If the test circuit of Fig. 3 (of the previous article), were a relaxation oscillator, a current of .93 A should flow from the DP, charging C3 and C5 with the energy to be released in the reactor flashes. A current of .93 A from a source of 570 V is 530 W. Referring to Fig. 1 of this article, the power from the DP is the lower curve in each graph, and the power to the CP is the upper curve. The bottom graph has an enlarged Y-axis, with major divisions representing 1 kW.

If the circuit were operating in a relaxation oscillator mode, the 530 W power from the DP would be clearly visible. It is simply not there.

Fig. 2 shows two pulses of a three pulse set of data for a run which begins with "No plasma discharge; background levels for input and output" (Correa notes). The total data set duration was 780 ms. The repetition rate was 2.8 pps. Energy in from the DP was 48.4 joules and energy out to the CP was 1071.9 joules. (Correa data)

In the lower graph, the minor divisions represent 125 watts of power on the Y-axis and 2.5 ms of time on the X-axis.

The curves have the same general aspect as Fig. 4c of the previous article. The power from the DP is represented (for the first event) by a pulse of about 200 W lasting for about 12.5 ms.

Immediately after the event, the DP power output drops into the noise floor of the instrumentation. The presence of noise spikes shows that the instrumentation is active and sensitive to powers in the tens of watts. Just before the second event Correa notes "No plasma discharge, input background level" After the second event,

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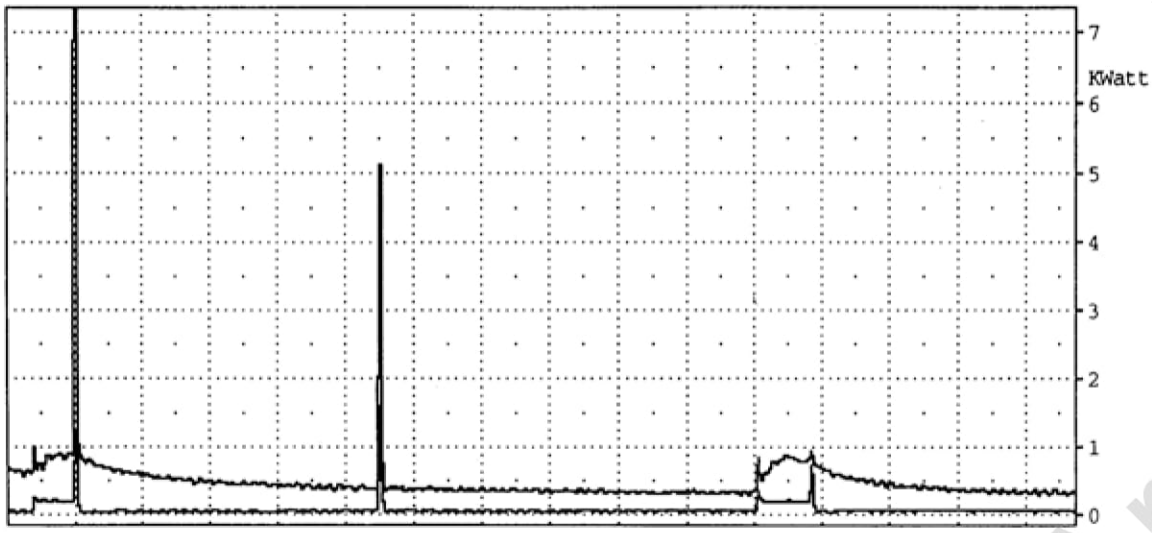

FIG. 3

the power From the DP does go immediately to background levels, but decreases with time (Correa comment), until the next event.

Fig. 3 shows another example taken from a longer run. Again, the upper curve is the power delivered: to the CP and the lower is the power extracted from the DP. Once again, the instrumentation is sensitive enough to detect noise, and there is essentially no power drain from the DP between pulses.

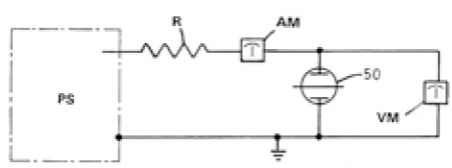

Fig. 20A **Fig. 4**

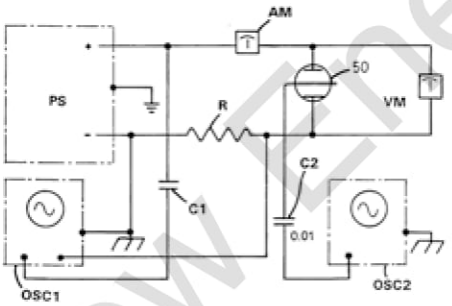

Fig. 20B **Fig. 5**

The three sets of data, two from this article, and Fig. 4 of the previous article, suggest that the energy events take many forms, depending on operating conditions, but there is a consistent aspect of over-unity performance. Also illustrated is the difficulty of measurements which would unequivocally show o/u performance.

PAGD Characterization

US patent #5,502,354, issued 26 March 1996 to the Correas contains data from early work in characterizing the PAGD phenomenon itself. For the purpose they used two test circuits, which are reproduced here as Fig. 4 and Fig. 5.

The only shunt capacitor is in the power supply output, and the ballast resistor R. in the range of 10^3 to 10^6 ohms, isolates it from the reactor. This is not the traditional relaxation oscillator circuit, where the capacitor shuts the discharge tube itself.

The patent contains 15 graphs and 17 tables in 38 pages, showing the eflect of various parameters on the performance of the PAGD reactor. Salient features of the discussion are noted below, emphasizing the nature of the PAGD phenomenon as distinct from the prior art.

PAGD Charactenstics

1. Repetitive, self-extinguishing, energy-producing discharges with only a stable voltage source and current limiting resistor as external circuit support.
2. Pulse rate a function of electrode area and spacing, reactor gas pressure, drive current, electrode composition, source voltage.
3. Static capacitance of reactor in the range of a few pF. Pulse rates in the range of 0.01 to >5,000 PPS. Series resistors used in tests in range 10^3 — 10^6 ohms. Such numbers are inconsistent with assumptions of relaxation oscillator action.
4. Strong field emission is necessary and is observed at field gradients lower by a factor of 10^5 than that predicted by theory.
5. Absence of thermionic emission from the cathode.
6. Pulse energy out/in ratios ranged from 1.5 to >50 for examples tested. Power output ranged from 25 to 400 watts.
7. Based on charge production and source voltage a dynamic capacitance for different reactors can be estimated at 100 μF to 80,000 μF.

Cathode Erosion

Aluminum alloys are a preferred material for the cathodes and are eroded by the discharges, as illustrated in Fig. 6.

Measurements of the material ejected from the cathode indicate 5.8×10^{-8} g, or 1.3×10^{15} Al ions per pulse for one case. The kinetic energy of the ejected material is more than three orders of magnitude greater than found by Tandberg for a Vacuum Arc Discharge.

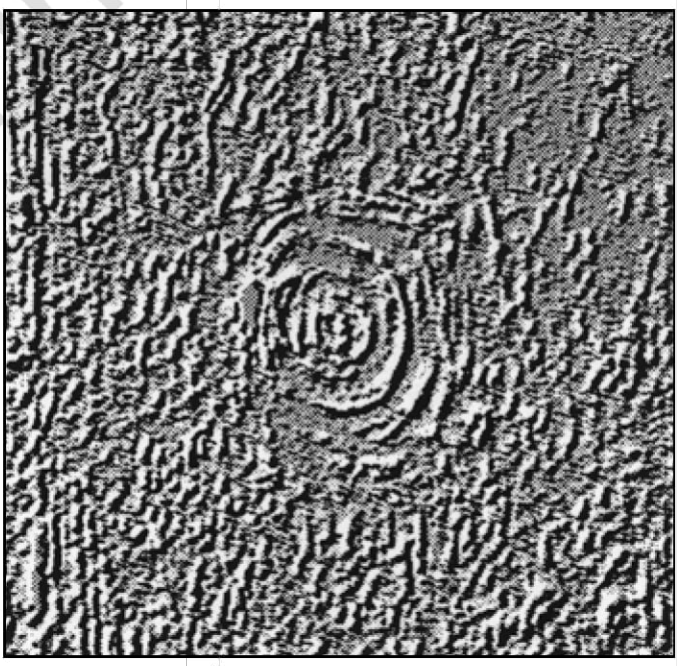

Figure 6. Erosion of of an aluminum PAGD cathode - Photomicrograph, *Copyright 1996 Correa&Correa*

Reaction Forces against the cathode in excess of 300 dynes have been observed

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in PAGD experiments.

The erosion suggests the presence of energies only three orders of magnitude less than Aspden's estimate of the energy priming the vacuum. The energies are of the same order as those found in water-plasma arc explosions by the Greneaus.

This erosion leads to questions about the working life of a PAGD reactor. Estimates in the patent suggest a lifetime energy output of as much as 40 megawatt-hours for a reactor. While the electrode material is eroded, there is no suggestion that the energy source is a nuclear reaction in the electrode.

PAGD Phenomena

The pulse repetition rate depends, among other things listed above, on the time it takes charge carriers to redistribute within the reactor volume after a discharge event.

The event begins with the driving current enabling a glow to cover the cathode and go into saturation. Beyond that, the voltage across the electrodes rises and the field effect emission begins. The glow is attenuated and a cone-like discharge column appears with a faint glow elsewhere on the cathode.

Within the discharge column, very intense energy is released, resulting in the pitting mentioned above, but also releasing electrical energy which is captured by the output circuit of Fig. 3 of the previous article.

Examination of the discharge column suggests the presence of a vortex of energy, which is also suggested by the photomicrograph of a crater in Fig. 6. The work of Aspden indicates a segregation of positive and negative charge carriers, and the development of strong longitudinal forces within the discharge column.

The above comments only point to the existence of a very complex phenomenon discovered by the Correas, which warrants study in its own right.

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The Wright Brothers and Cold Fusion

by Jed Rothwell

Hart O. Berg was an engineer and high tech military-industrial wheeler-dealer. He was an agent for the Charles Flint Company, an investment firm that organized trusts and once sold an entire naval fleet to Brazil. Berg managed the European operations, selling American submarines, machine guns, and electric automobiles. In 1908 he sold the airplane to the world. If he had not done that, Wilbur Wright would have died in obscurity in 1912, carrying many of his secrets to the grave. T.O.M. Sopwith and a half-million other people would not have latched onto aviation and developed it intensively before World War I. The airplane would not have been ready. The allies would have lost without the Sopwith Pup and Camel. Or if they had pulled through, they would have lost the Battle of Britain twenty years later without Sopwith's Hurricane fighters. Berg, the Wrights, and Sopwith together twice saved Western civilization by the narrowest of margins. The high tech entrepreneur Berg changed history by showing the Wrights how to make money.

People often ask: if cold fusion is real why is it ignored and attacked? I say we have been down this road before. People had to fight to win acceptance for antiseptics, amorphous semiconductors, and even the transcontinental railroad. There are many lessons for cold fusion in the Wright story. Here are a few of them:

History is not inevitable. If the Wrights had not built the airplane, man would not have flown for another 10 or 20 years, most experts agree. History is a product of free will. People make decisions, take actions, and shape events. Things do not get invented just because they are needed. We learn to live with awkward machines like the automobile transmission. If Bell Labs had not come up with the transistor, by now we would have computers with a million "vacuum tubes on a chip." (I recall seeing of a photograph of such a chip, fabricated for a special application a few years ago. Technology is flexible; transistors are not the only things you can miniaturize.)

New technology is unpredictable; the only way to get a handle on it is to use it. When something new bursts upon the scene, you cannot predict where it will go or who will be the leading players. The Wrights, Tom Sopwith, Bill Gates or Michael Dell beat the big guys because they know the technology. The only way to master technology is to get a machine and play with it. In the 1980s IBM lost out because its managers did not use computers. As Paul Carroll of the *Wall Street Journal* put it: "IBM had become like a music-publishing company run by deaf people."[1]

Fig. 1. October 7, 1903, Langley's Aerodrome plunges into the Potomac River

To introduce a new technology you must fight two groups of people: the scientists who oppose it and the scientists who invent it. The Wrights were their own worst enemies from 1906 to 1908. After battling with the establishment for five years, they began acting like paranoid flakes. Some cold fusion scientists are worse.

It is never easy to sell revolutionary technology. Invent a better mousetrap and the world will beat a path to your door, burn your house down, and run you out of town.

The Wright's History

Although it is well documented, the Wrights' history is not well known. Myths, misperceptions, jealousy and revisionist history have obscured the facts.[2] Their achievement deeply embarrassed the establishment. *Scientific American* has been trying to rewrite its buffoonish role in the affair for

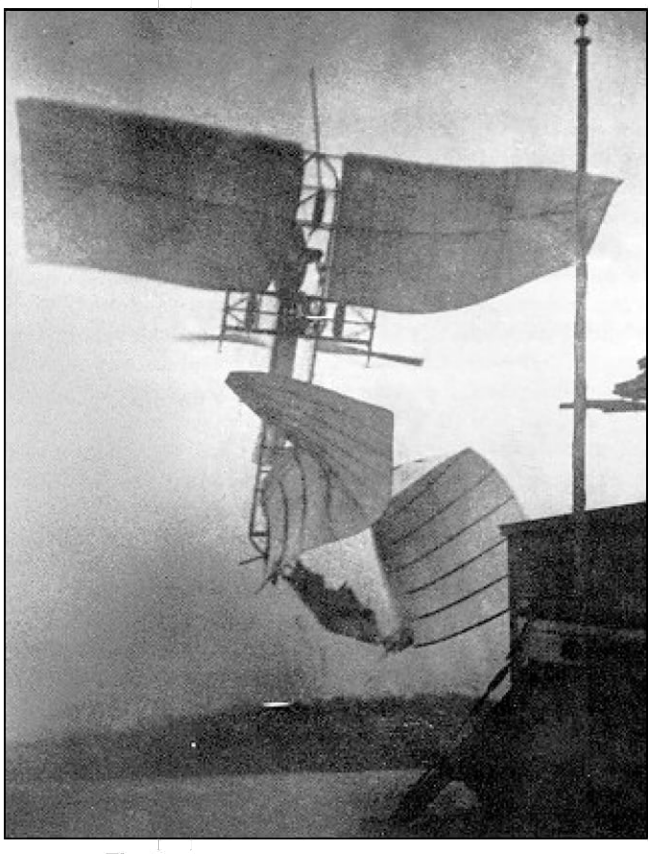

Fig. 2. December 8, 1903, the Aerodrome collapses, plunges into Potomac

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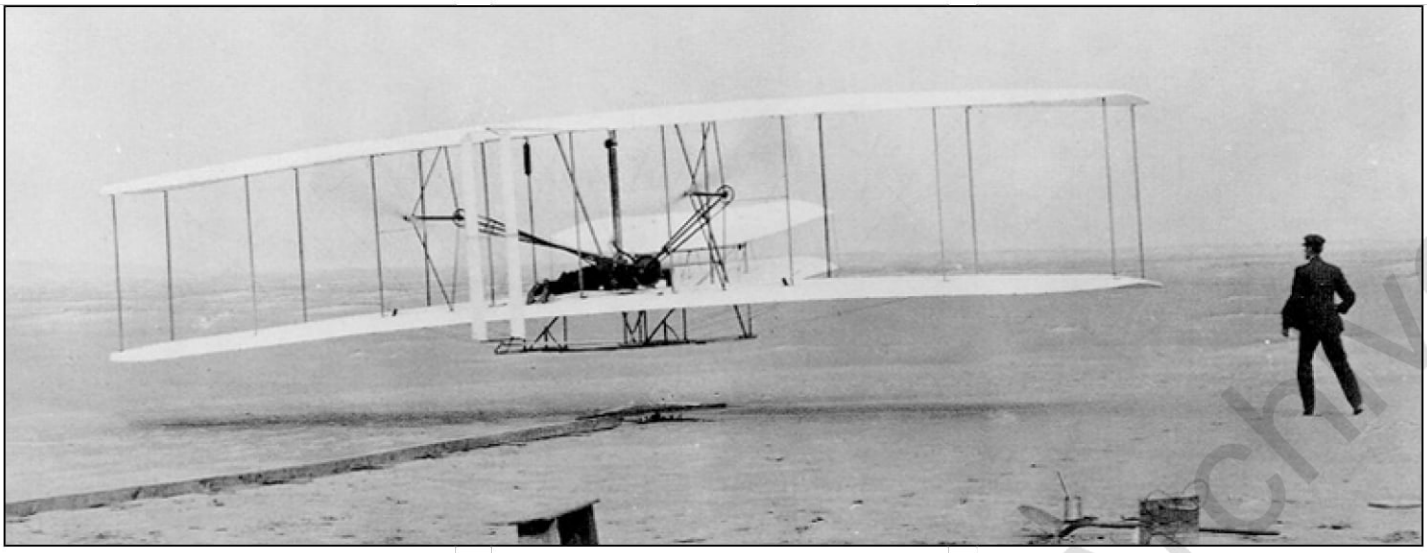

Fig. 3. **Kitty Hawk, North Carolina, December 17, 1903, 10:30 a.m.**

the affair for years, most recently in a 1993 article![3] The Smithsonian Institution denigrated the Wrights for years in a feud over Langley's priority.

In 1900 a small band of scientists worked at the fringes of respectability, trying to learn to fly. Some were distinguished men like Alexander Graham Bell, Langley, Maxim and Chanute. They were old, discouraged, and lonely. Little progress had been made since the death of Otto Lilienthal. Young scientists would not touch the field. That is true of cold fusion today: our champions are the old mavericks like Bockris and Fleischmann. In 1900 there was only one serious, properly funded aviation R&D program in the world. It was at the Smithsonian, where the director, Langley, was trying to scale up his steam driven small models that had flown successfully in 1895. To the vast majority of other scientists, and in all popular journals and newspapers, the issue was settled. A heavier-than-air flying machine was physically impossible. It was an absurdity, a gross violation of the laws of nature. This had been proved mathematically with "unassailable logic" by leading experts in physics, writing in distinguished journals and magazines.[4]

We admire Chanute and Langley, but the fact is they were stuck, just as most cold fusion scientists are stuck today. The field was "moribund," as one expert says.[5] Langley's experiments ended in a fiasco in December 1903. He was lambasted by the press and by Congress for wasting $50,000 of the taxpayer's money. There was, at that moment, nothing left of aviation — not a single research project and seemingly no hope of success, until the Wrights few two weeks later at Kitty Hawk . . . in one of history's great ironies.

Going back to 1898, what aviation needed was new blood and a spark of genius. It got that in Wilbur and Orville Wright. Let me puncture myth number one here. The popular image is that they were small town bicycle mechanics who by trial and error stumbled on a workable design. Nothing could be further from the truth. They were scientific geniuses. They invented the airplane by observation, experiment, database compilation, and analysis. They performed highly complex mathematical modeling of everything from the wings, the fuselage and propeller to the wind resistance of the pilot's head. Their wind tunnel data was so accurate, it was not improved upon until the 1920s. Before they cut wood to build the first propeller, they modeled it, optimized it, and predicted its performance. They got it right to within one percent.[7,8] Their science, engineering, craftsmanship, and experimental technique were beautiful. Their work has the distilled elegance you see in Faraday's experiments and Niklaus Wirth's program code. They were wonderful scientists and lousy businessmen.

They first flew in 1903. In 1904 and '05 they flew on Huffman Prairie, next to the trolley car line in Dayton, Ohio, where many people saw them. When the Wrights were later accused of secrecy, they produced a list of more than 60 people who had witnessed flights. They had signed affidavits from leading citizens of Dayton, the city auditor, a bank president and so on. Their longest flight was 24 miles.

The Wrights stopped flying from 1906 to mid-1908. They devoted much of this time to pursuing business deals in the U.S. and Europe. They also built improved airplanes and engines. In late 1906 the Charles Flint Company contacted them and agreed to act as their agents.

The Wrights spent three years trying to peddle their machine to national governments, getting nowhere. They asked for no down payment, but they demanded a written guarantee that the customer would pay after a successful demonstration. That may seem reasonable, but not to a customer who thinks your machine is impossible and you're crazy. When French and British government agents visited the Wrights in Dayton, they were shown photographs and affidavits, but no flights, because the Wrights would not fly without a contract. The agents reported back to headquarters that the claims must be true. It was not enough. The Wrights should have followed up by sending photographs and documentation. They should have understood that these negotiations required approval at the highest levels, and you cannot ask the French Minister of War to come to Dayton. As Crouch says: "a personal visit to Washington with a handful of the astonishing photos of the long flights of 1904-95, accompanied by affidavits from the Huffman Prairie witnesses, would surely have convinced the [Army] board."[9] The cold fusion scientists make the very same mistakes! They should circulate more data, more photos, and they should perform more demonstrations. They should stop trying to sell their machines to governments and big corporations who do not want them, and find live customers who do.

The French capitalists who were backing a syndicate pushed the Wrights to make a demonstration flight. The Wrights intended to do one eventually, but they procrastinated. If the capitalists had not pushed them, history would have passed the Wrights by and the aviation boom would have been delayed two or three more years. Fortunately, things got moving. In Washington, President Theodore Roosevelt personally intervened to break the logjam. At last, in December 1907 the

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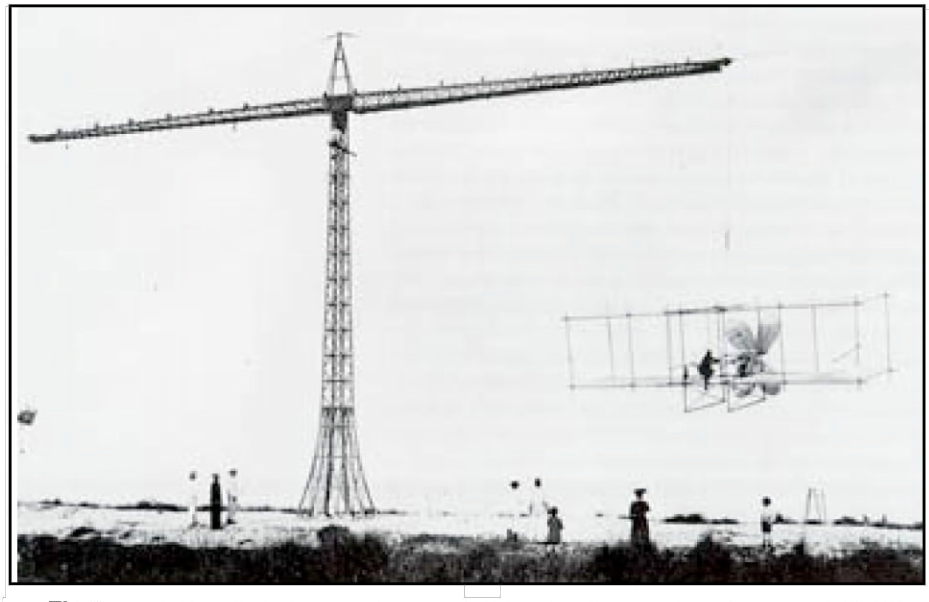

Fig 4. How Not To Replicate. French army captain Ferdinand Ferber tests his powered Wright-type glider, suspended from a huge whirling arm, near Nice in June 1903.

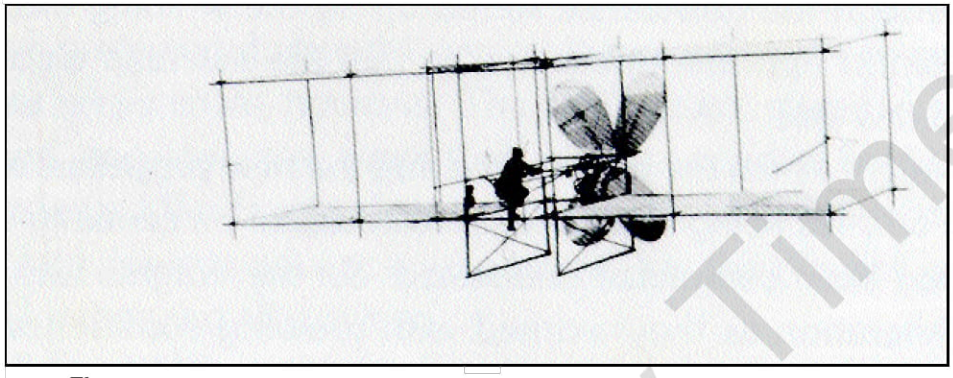

Fig. 5. Close-up of the Ferber non-flying airplane. Note flat wings and absurd propeller design.

Roosevelt personally intervened to break the logjam. At last, in December 1907 the Army Signal Corps agreed that if the Wrights could do a demonstration flight, carrying a passenger at 40 mph over a distance of 10 miles, they would be paid $25,000. The press lambasted the War Department for encouraging crackpots. Newspapers said that if an airplane capable of doing this existed, everyone would already know about it and it would be worth millions, so why would the inventors settle for a mere $25,000? As the New York *Globe* put it:[10]

One might be inclined to assume from the following announcement, "the United States Army is asking bids for a military airship," that the era of practical human flight had arrived . . . A very brief examination of the conditions imposed and the reward offered for successful bidders suffices, however, to prove this assumption a delusion.

A machine such as is described in the Signal Corps' specifications would record the solution of all the difficulties in the way of the heavier-than-air airship, and, in fact, finally give mankind almost as complete control of the air as it now has of the land and the water. It would be worth to the world almost any number of millions of dollars, would certainly revolutionize warfare and possibly the transportation of passengers . . .

Nothing in any way approaching such a machine has ever been constructed (the Wright brother's claims still await public confirmation) . . . If there is any possibility that such an airship is within measurable distance of perfection any government could well afford to provide its inventor with unlimited resources and promise him a prize, in case of success, running into the millions.

. . . in other words, we shouldn't have a demonstration because we already know it doesn't work because there hasn't been a demonstration. A Catch 22! We hear the same stuff from the cold fusion opposition today.

The story has a happy ending. On August 8, 1908, Wilbur made a flight in front a few hundred people in France. Within days he was a hero on the front page of every European newspaper. He was given gold medals, thousands of dollars in prizes, and contracts in every European capital. Thousands of people flocked to see the flights. He wrote that "princes & millionaires are as thick as fleas." Meanwhile, not a word of the European frenzy reached the American newspapers. So, on September 3, when Orville prepared for his first test flight at Fort Meyer, only a few hundred people turned out to see him. President Roosevelt's son was there. Orville took off, circled the field one-and-a-half times, and landed after a minute and eleven seconds. Years later Roosevelt described the scene:

"[The crowd] went crazy. When the plane first rose, the crowd's gasp of astonishment was not alone at the wonder of it, but because it was so unexpected. I'll never forget the impression that sound from the crowd made on me. It was a sound of complete surprise."

The lesson is obvious. People believe what they see with their own eyes. The only way to convince people that revolutionary new technology is real is to demonstrate it in public. Let the whole world see it. Put it into the hands of as many customers as you can, as quickly as possible. Cold fusion scientists today are asking only fellow scientists to look at their data. It is as if Wrights showed wind tunnel data instead of airplanes, and talked to a few other scientists while ignoring the public.

Secrecy

Another myth is that the Wrights were deeply secretive about their work. This was the establishment's excuse for the five years of official neglect after Kitty Hawk. Here is a wonderful section from the authorized biography: [11]

Dan Kumler . . . city editor *Daily News*, in Dayton, recalled in 1940, . . . that many people who had been on interurban cars passing the Huffman field and seen the Wrights in the air used to come to the *Daily News* office to inquire why there was nothing in the paper about the flights.

"Such callers," said Kumler, "got to be a nuisance."

"And why wasn't there anything in the paper?" Kumler was asked.

"We just didn't believe it," he said. "Of course you remember that the Wrights at that time were terribly secretive."

"You mean they were secretive about the fact that they were flying over an open field?"

"I guess," said Kumler, grinning, after a

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moment's reflection, "the truth is that we were just plain dumb."

Today, people say we are secret. I say "you mean we are secretive about the fact that MITI is sponsoring an international conference next month?" However, it is true that Wrights and the cold fusion scientists became secretive over time. A few years ago Pons and Fleischmann were showing videos of boiling cells and publishing papers in major journals. Now we hear nothing from them. Even after they got a patent, the Wrights did squirrely things like publishing blurred photographs, to hide details. They made up strange justifications for their strategy, such as the idea that the airplane is more valuable as a secret weapon: the British will pay more if the Germans have not seen it. "The less other governments know, the more it is worth to the purchaser. At present we are able to give positive assurance to any government that other governments have not seen the machine."[12] They gave two main reasons for their secrecy; reasons I have heard many times from cold fusion scientists:

1. Some design improvements were not covered in the 1906 patent. Why didn't they simply file another patent?

2. The competition was far behind, and making little progress in spite of the patent. The Wrights thought this gave them a precious lead they should "conserve." In 1907 they wrote to Charles Flint: "We can furnish governments with practical machines . . . *now*: no one else can. There is no certainty that anyone else is within three years of us . . . The progress made by others since the announcement of our final success at the end of 1905 is as rapid as could reasonably be expected, but it by no means indicates that others will reach the goal in less time than we required."[13]

Their strategy was predicated on the preposterous idea that you can keep a patented airplane secret. It never seems to have occurred to them that once intense public interest ignites, the quality of replications must improve dramatically. Furthermore, they did not grasp that *it is much easier to replicate than it is to invent something in the first place*. They should have seen that only third-rate people were trying replicate them during this period, but that in a boom thousands of talented people would soon get to work and progress would be immeasurably swifter. I am distressed to read that Charles Flint agreed with their tactics of keeping the invention under wraps. Many of the entrepreneurs backing cold fusion make this same mistake. They have the same mindset as the scientists.

Many cold fusion scientists want praise and recognition, but they do not want people to steal their ideas, so they play peek-a-boo with their results. Like the Wrights, they are concerned about losing their lead, and like the Wrights I am sure they will lose

Applied Science, Not Physics

The Wrights did applied science, not basic physics. From their wind tunnel work, they compiled data tables titled "Gliding pressure," "Tangentials, gliding angles, drag: lift ratios" and so on. They used this data to determine the proper shape and chamber of the wings, the separation of the wings, fuselage shape, the design of the propellers and a host of other essential design parameters. They modeled the performance of their machines before building them. Then, based on actual performance of the full-scale machines, revised and refined the models. They could not have done it any other way. It would have taken too much time and money, and flight testing would have been too dangerous. As it was, both brothers were suffered dozens of crashes, some nearly fatal. Regarding the development of theory, Crouch writes:

Engineering was the key. The Wright brothers function as engineers, not scientists. Science, the drive to understand the ultimate principles at work in the universe, had little to do with the invention of the airplane. A scientist would have asked the most basic questions. How does the wing of a bird generate lift? What are the physical laws that explain the phenomena of flight?

The answers to those questions were not available to Wilbur and Orville Wright, or to anyone else at the turn of the century. Airplanes would be flying for a full quarter century before physicists and mathematicians could explain why wings worked.

How was it possible to build a flying machine without first understanding the principles involved? In the late twentieth century, we regard the flow of technological marvels from basic scientific research as the natural order of things. But this relationship between what one scholar, Edwin Layton, has described as the "mirror image twins" of science and technology is a relatively new phenomenon. Historically, technological advance has more often preceded and even inspired scientific understanding.

T. Crouch, *The Bishop's Boys*, (Norton: 1989), page 175

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How To Do Research Right

Much has been written about how to do science and research and development correctly, and how to develop products on time and on budget. Few people in history have understood the essence of this problem better than the Wrights, and few people have expressed it better than Wilbur did, fifteen days before his untimely death, in a text he was preparing for the Aero Club of America:

> When the general excellence of the work of Lilienthal is considered, the question arises as to whether or not he would have solved the problem of human flight if his untimely death in 1896 had not interrupted his efforts . . . One of the greatest difficulties of the problem has been little understood by the world at large. This was the fact that those who aspired to solve the problem were constantly pursued by expense, danger, and time. In order to succeed it was not only necessary to make progress, but it was necessary to make progress at a sufficient rate to reach the goal before money gave out, or before accident intervened, or before the portion of life allowable for such work was past. The problem was so vast and many-sided that no one could hope to win unless he possessed unusual ability to grasp the essential points, and to ignore the nonessentials . . . When the detailed story is written of the means by which success in human flight was finally attained, it will be seen that this success was not won by spending more time than others had spent, nor by taking greater risks than others had taken.
>
> Those who failed for lack of time had already used more time than was necessary; those who failed for lack of money had already spent more money than was necessary; and those who were cut off by accident had previously enjoyed as many lucky escapes as reasonably could be expected.
>
> Lilienthal progressed, but not very rapidly. His tables of pressures and resistances of arched aeroplane surfaces were the results of years of experiment and were the best in existence, yet they were not sufficiently accurate to enable anyone to construct a machine with full assurance that it would give exactly the expected results. Under such conditions progress could not but be slow. His methods of controlling balance both laterally and longitudinally were exceedingly crude and quite insufficient. Although he experimented for six successive years 1891 - 1896 with gliding machines, he was using at the end the same inadequate method of control with which he started. His rate of progress during these years makes it doubtful whether he would have achieved full success in the near future if his life had been spared . . .

The part about: "Those who failed for lack of time . . ." should be framed and mounted above the workbench of every cold fusion scientist. I am reminded of what Raphael Soyer used to say (and what his teacher told him, at the Art Students League): "You have time, but not an OCEAN of time."

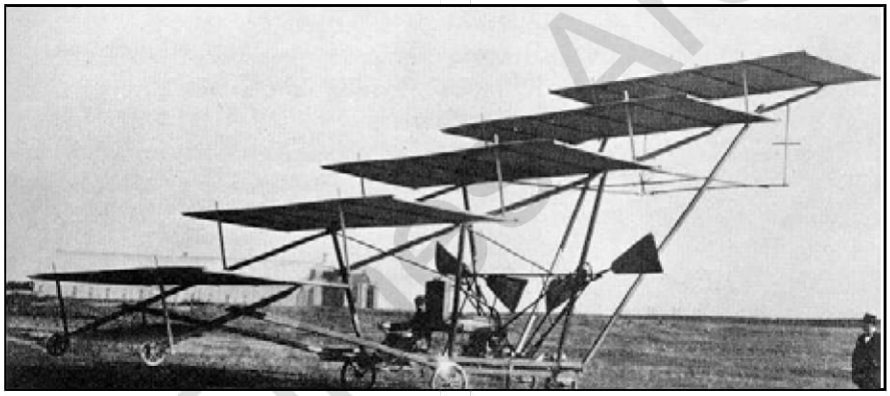

Fig 6. How Not To Replicate II. Two steps beyond the triplane, the five-decker Mertz multiplane was never able to achieve sustained flight in its trials at Johannisthal (1910).
- H. Villard, "Contact!," (Crowell, 1968), p. 215.

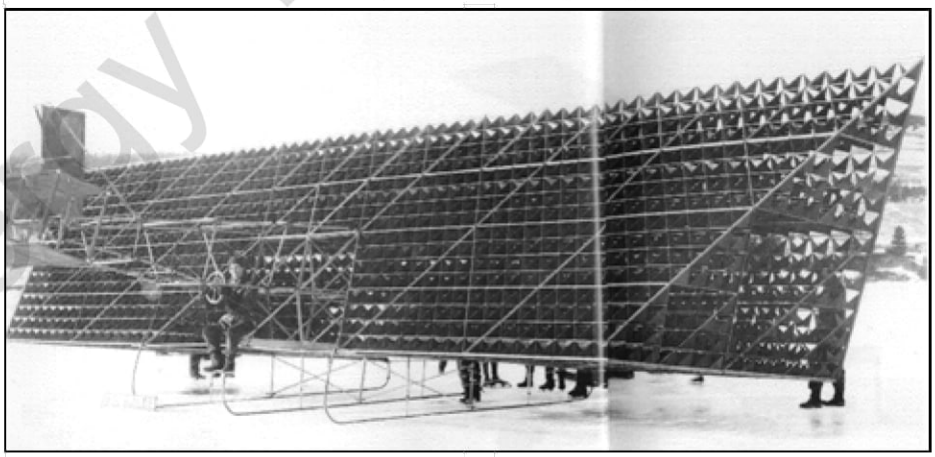

Fig. 7. How Not To Replicate III. Alexander Graham Bell's Cygnet II, February 1909
- B. Yenne, "The World's Worst Airplanes," (Dorset Press, 1993), p. 19.

it a few months after they go public. Nothing becomes obsolete faster than the early models of a new technology. Think of the microcomputers of the 1970s: the TRS-80, SOL, North Star and Cromemco. It is absurd to worry about being overtaken. You will be competing with every industrial corporation on earth; of course you will be overtaken! If you have no patent then you have no protection, so you might as well give the technology away. And if do have a patent, the competition will find out everything there is to know the moment they take you seriously. Either way, there is no point in keeping it secret.

Incremental improvements to established technology must be kept secret. Revolutionary devices that are still at the impractical stage must be made public, or they will never attract the critical mass of people necessary to make them into practical, commercial products. The Wrights' secrecy and their precious three-year lead turned out to be millstones around their necks. They finally began earning money and recognition after they went public.

No Replications and Little Progress Until 1908

News of the Wrights work caused a rebirth of interest in aviation, particularly in France. Yet nobody else flew until 1906, when Santos-Dumont staggered off the ground in barely controlled hops. The French tried some of the innovations the Wrights described in their papers and patents, which circulated widely. But nobody tried all of the innovations in a single careful copy of the patent. For seven years, nobody really tried to replicate. Popular revisionist history books still blame the Wrights because the French did

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Early Aviation Time Line

1890s Progress in aviation "moribund" [Crouch] as Lilienthal and Pilcher are killed gliding, and experiments by Chanute, Maxim and others peter out. Only Langley continues.
1895 The Wrights become seriously interested in aviation.
1899 First kite experiments with wing warping.
1900 Tests at Kitty Hawk.
1901 Invent wind tunnel, compile world's first reliable data on airfoils.
First published paper in the Proc. Western Society of Engineers.
1902 Tests at Kitty Hawk.
1903 Second paper in Proc. Western Society of Engineers.
Ferber tests a "Wright-type" glider suspended from a huge whirling arm in Nice, France
October and December: Langley attempts two flights, which end in disaster.
December 17: First powered flight at Kitty Hawk.
1904 Test flights at Simms Station trolley car stop, Dayton Ohio. First turns exhibit complete control. Flights are widely observed. Leading citizens of Dayton sign affidavits. Press ignores or attacks Wrights.
British and French government agents contact Wrights, first attempts to sell airplane to governments.
1905 Continued testing. Airplane now "a machine of practical utility" [O. Wright].
Longest test flight 24 miles in 39 minutes.
Continued attempts to sell airplane to governments.
1906 Patent granted.
In France, Santos-Dumont makes first flight by anyone other than Wrights; nearly uncontrolled 50 meter hop. Europeans become excited about aviation.
Continued fruitless attempts to sell airplane to governments.
Scientific American again attacks Wrights.
Wrights publish a list of 17 leading citizens of Dayton who have observed flights. (They have a list of 60 witnesses.) *Scientific American* at last contacts witnesses, and in November sends an editor to meet with Wrights.
November, first contact from Charles Flint Company.
Charles Flint Company acts as the Wrights agents.
December, *Scientific American* finally retracts and endorses flights. Most other journals continue to ignore or attack them.
1907 Continued fruitless attempts to sell airplanes to governments.
President Roosevelt sees clipping from *Scientific American*, personally orders that the logjam should be broken and the Wrights invited to demonstrate airplane in Washington, but arrangements fall through because the War Department does not have $100,000 budget for purchase of an airplane.
In France, Farman makes first shallow, nearly uncontrolled turn.
December: after Roosevelt guarantees funds will be found, contract with War Department for payment of $25,000 contingent upon a successful demonstration flight. Press attacks War Department for signing contract.
1908 Continued fruitless attempts to sell airplanes to European governments.
Curtiss makes first serious attempt to replicate Wrights, resulting in first flight of over one kilometer by anyone other than Wrights; flight is barely controlled, skirts disaster.
June: Wrights fly for the first time in two and a half years with improved airplane, carry passenger for the first time.
August, Wrights publicly demonstrate flights in France and the U.S. All skeptical doubts and opposition instantly end.
First fatal airplane accident. Wilbur crashes, passenger Lt. Selfridge killed.
Wrights become international heros; first media stars of the 20th century. Business deals offered by lead ing U.S. and European capitalists.
Thousands of people begin replicating Wrights.
1909 Europeans take the lead in aviation.
1911 Special issue of *Scientific American* devoted to aviation reports that "more than half a million men are now actively engaged in some industrial enterprise that has to do with navigation of the air."
Wrights now spending much of their time in court fighting patent infringement.
1912 May, Wilbur dies of typhoid at age 45.
European armies begin serious pilot training and acquisition of airplanes.
1914 Igor Sikorsky's Ilia Mourometx multimotored airplane carries up to 16 passengers. It sets a record carry ing 6 passengers for 6 hours 33 minutes.
German military pilot in endurance test flies 1900 kilometers in 21 hours 50 minutes.
World War One begins. From the start, air reconnaissance is crucial.
1920s Wright wind tunnel data improved upon by others for the first time.
First physics theories developed to explain airfoil lift – but the issue is still not completely settled as of 1996.

blame the Wrights because the French did not do their homework. [14]

Figure 4 shows a famous example of how not to replicate, paid for by the French army in 1902. It built this whirling tower in Nice, France and suspended a biplane built by Captain Ferdinand Ferber. He said it was designed "along the same lines as" the Wright machines. Please note the wings are flat, not chambered. Ferber figured he did not need any fancy wing chambering or warping controls (flaps). He missed the whole point of their work!

You might think that scientists are more sophisticated today and they would never perform such inept "replications." Well, think again. A scientist at a National Laboratory once told me that he had done a close replication of the Mills experiment, except Mills used water and he decided to use acid instead. A few weeks ago Barry Merriman at the University of California announced that he had done a replication of the Patterson cell, and he saw no heat. [15] Well:

•Merriman used glass beads. Patterson used plastic. Merriman called that a "minor" difference but for all he knows it could be critical.

•Merriman has no idea whether his beads absorb hydrogen rapidly, as shown in the patents. He has not even measured that parameter; like Ferber, he ignored *the most critical point in the published work*.

•The man who fabricated the beads never saw the patents.

Many Frenchmen tried to replicate the Wrights apparently without bothering to read their scientific papers or patent. They thought they knew better than the Wrights. When their machines failed, they blamed the Wrights, saying the design was fraudulent. Today, many scientists who made equally ridiculous mistakes pontificate in the newspapers about how they proved cold fusion is wrong. They do what I call "South Pacific cargo-cult science," where you tie a pine cone to a stick, pretend it is a microphone, and you call down results from the sky. Going through the motions is not enough.

These non-replications share another quality with bad cold fusion experiments: more money and attention was lavished on the experimental apparatus than the actual device. Langley spent thousands on the elaborate launch platform built on top of

Fig. 8. **Hart O. Berg and Wilbur Wright**

the houseboat (Figure 1). The Wrights did a better job with a monorail costing a few dollars. The French Army must have spent a fortune on the whirling tower. Ferber's airplane looks like an afterthought in comparison. Langley built a similar whirling tower in Pennsylvania that cost many thousands. The Wrights did a far better job with a wind tunnel that cost less than $50. In cold fusion we have seen many splendid calorimeters and ultra high-tech neutron detectors hooked to sloppy, ill-prepared electrochemical cells.

Even after Farman, Voisin, Delagrange and others finally did manage to replicate the Wrights in 1908, they used empirical trial-and-error methods, instead of basing

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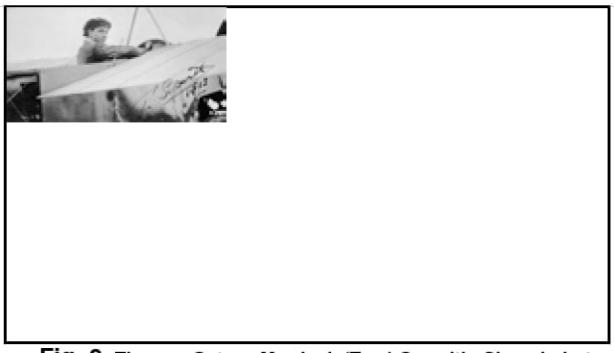

Fig. 9. **Thomas Octave Murdock (Tom) Sopwith. Signed photo dated 1913. This handsome young man "well off financially, had drifted into aviation from yachting . " Designed WWI Sopwith Camel, WWII Hurricane fighters - H. Villard, "Contact!," (Crowell, 1968), p. 193**

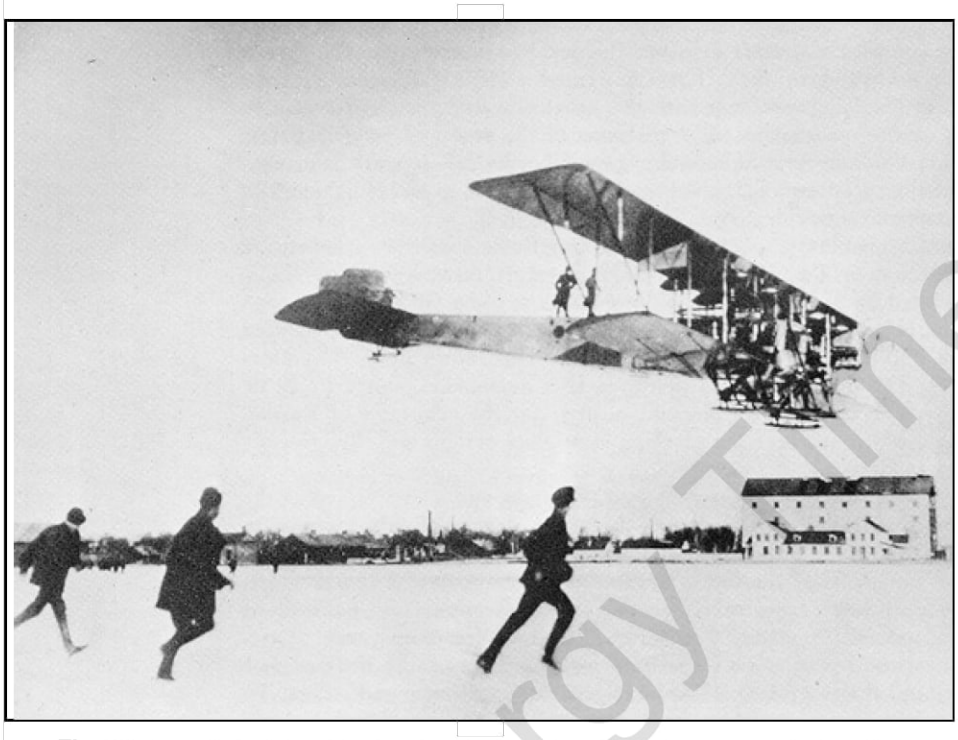

Fig. 10. **Using the facilities of a railroad-car factory, Russian aeroplane constructor Igor Sikorsky designed and built large, multimotored planes with roomy compartments for pilots and passengers. His *Ilia Mourometx* set a world record in 1914 by carrying sixteen passengers. It is shown here coming in for a landing with two men standing on the upper platform. (I.I. Sikorsky)**

their work on wind tunnel data and engineering analysis. The results were predictable. "It must have been an embarrassing situation, for despite having three and four and even five times as much engine power as was available to the Wrights, the thrust from their propellers gave them less flying power than the first Wright Flyer."[16]

The Aviation Boom

After the Wrights became international media stars, French airmen copied them carefully. Still, many screwball ideas were developed after in 1908. Alexander Graham Bell was no fool, but his Cygnet II never left the ground in 1909. In 1910 a Professor Mertz decided that if two wings were good, five wings must be better. But, for every Bell or Mertz there were soon dozens of talented people who got it right. By 1911, *Scientific American* said that a half-million men were working on aviation. Progress over the six years before the First World War was unprecedented. It was free-for-all competition. If you want rapid progress, you must make room for screwballs like Mertz along with geniuses like Sopwith. The boom culminated in 1914 when Igor Sikorsky set a record carrying six passengers for 6 hours 33 minutes in the *Ilia Mourometx*, a multimotored enclosed airplane that could carry 16 passengers in comfort.[17]

If the Wrights had not demonstrated the airplane to the world, progress would have limped along the way it did from 1901 to 1908, with just a handful of people. It takes thousands of people to develop revolutionary technology. Each individual works on his own ideas, in chaotic competition. An organized, centrally directed project like MITI's will not cut the mustard. The 1908 demonstrations galvanized the world. Without it, aviation would not have advanced enough to play a significant role in the war. The allies, who depended on a thin edge of technological superiority, might have lost.

Dealing With Geniuses

When Hart Berg met Wilbur, he wrote a wonderful letter to his headquarters describing what it is like working with a stubborn genius. People who get involved with cold fusion must learn deal with people like this. Here is part of the letter: [18]

At 12:30 yesterday I met Mr. Wilbur Wright at Euston Station. I have never seen a picture of him, or had him described to me in any way, still he was the first man I spoke to, and either I am Sherlock Holmes, or Wright has that peculiar glint of genius in his eye which left no doubt in my mind as to who he was . . .

The company idea did seem to please him very much, as he first wanted to know himself exactly what the attitudes of the several governments were. After a long talk . . . I believe, please note that I say distinctly "I believe," that I made something of an impression as regards the impossibility of getting any sort of action in the near future from any government. He agreed he did not think the British Government would do any business. He also stated that perhaps it would be very hard to do anything with the French Government . . .

About 5 o'clock in the afternoon, I think, you will distinctly note that I said "I think," I brought about some sort of action in his mind, and think he was on the point, you will note that I say that "I think he was on the point," of veering around from the government to company methods. . . .

FOOTNOTES

1. P. Carroll, *Big Blues - The Unmaking of IBM*, (Crown Publishers, 1993).

2. A. Golin, *No Longer an Island, Britain and the Wright Brothers 1902-I 909*, (Stanford University Press, 1984), p. 31-33.

3. Reprint of book review of *The Wright Brothers: A Biography Authorized by Orville Wright* in the "50 and 100 Years Ago" column, July 1993.

4. F. Kelly, *The Wright Brothers: A Biography Authorized by Orville Wright*, (Harcourt, Brace and Company, New York, 1943), p. 116, describing Simon Newcomb.

5. T. Crouch, *The Bishop's Boys*, (Norton: 1989), p. 231. See also: T. Crouch, *A Dream Of Wings*, (Smithsonian Institution Press, 1985) for a detailed history of aviation before the Wrights.

6. H. Combes, *Kill Devil Hills*, (TernStyle Press, 1979), p. 119.

7. Combes, p. 186, and noted by most other biographies.

8. Golin, p. 34. Gollin quotes British expert J. L. Prichard's description of the propeller design: "Of such stuff is genius made!"

9. Crouch, p. 305.

10. Kelly, p. 209.

11. Kelly, p. 135.

12. Wright's letter to Flint, April 12, 1907, quoted by Gollin, p 221.

13. Gollin, p. 243. See discussion of opinions of the Wrights and Flint during this period, pp. 240 250.

14. For example, see: C. Pendergrast, *The First Aviators*, (Time-Life Books, 1981), p. 7, p. 17.

15. Published on the World Wide Web http://www.math.ucla.edu/~barry/CF/CETIX.html

16. Combs, p. 181

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AquaFuel — A Wonder Fuel, but is it Over-Unity?

by Eugene Mallove

Just when we thought over-unity effects could not be found in anything simpler than light water electrolysis, or hydrogen gas in contact with heated metal substrates, along comes "AquaFuel," a patented process that is shockingly simple. That may be a problem: *it's too simple, so"Why didn't anyone notice this before?"*

AquaFuel is the gas produced from ordinary water during low-voltage discharge across a carbon arc. *No electrolyte* is used. The 3,000 °C to 4,000 °C arc dissociates the water and combines H, O, and C to make the gas. Underwater welders on naval vessels have been creating this gas for years, assuming all along, some suggest, that it was *steam*. Remember too that, "Buckyballs", C_{60} molecules, had been produced by generations of high school chemistry students in their Bunsen burners, but nobody noticed them until they were identified in the 1980s. Who knows, maybe Buckyball chemistry has something to do with how AquaFuel works.

There it is on the cover of this issue, bubbling up from a carbon rod arc in a simple table-top experiment in a fishbowl The photo was made by Joseph E. Bollent of Tampa, Florida—an ex-WWII combat veteran who acts as a spokesman for the "Aquafuel Association."

In the photo, a gallon fishbowl is 3/4 filled with plain tap water. Copper tubing conducts 24 volts DC to the tip of a 0.25-inch diameter carbon rod. An electric arc tunnels through the water a short distance to a large diameter carbon block, and the current flow continues through the other copper tube lead to the 24V supply, which could be automobile storage batteries. The inverted funnel is a convenient method for collecting the gas, which burns above.

William H. Richardson, Jr., the fuel's mechanically talented inventor, holds a U.S. patent (#5,435,274, granted July 25, 1995) on producing the gaseous fuel. [We reproduce the full patent here, "Electrical Power Generation Without Harmful Emissions," because of its *potential* importance.] The *implication* in the patent, and from numbers quoted by the inventor, is that the fuel combusts with air to produce more energy than the electric power required to generate the gas. This claim has *not* been verified by any outside source, so it remains just that— a claim. And one also has to be careful, because along with the electrical input power, there is chemical energy released by the carbon of the carbon arc combusting with oxygen in the dissociated water. But the claimed numbers provided to *Infinite Energy* by Bill Richardson look very good, indeed.

Richardson says that in at least a dozen tests using a utility company-certified power meter on the wall-power input side of an AC-arc welder, he was able to produce a standard 80 ft^3 volume of Aquafuel gas (at ambient temperature and pressure) with only 1.0 kilowatt-hour of wall -supplied electricity. This gas, when provided (with the proper air mixture) to a 5 horsepower Briggs & Stratton engine coupled to a 2.5 kW electric AC generator, lit up brightly a 2,200 watt array of light bulbs (22 hundred-watt incandescent bulbs) for 35 minutes! If the internal combustion engine were even as much as 20% efficient (it is probably less than that), the total energy output over the input electric energy is over 6-to-1. That does not even account for the considerable heat produced in the water tank by the arc, nor the generator and arc-welder thermal losses, which are potentially recoverable for use as process heat.

The situation is a bit more complicated than that, however, because of the chemical combining energy of the carbon rod fed into the arc, but more about that below.

As we went to press with *IE* Issue #9, we were gearing up in our Bow, NH laboratory, to test the Richardson claim experimentally (results to be presented in Issue #10.) Has Richardson made a mistake, or is this a potential wonder fuel tapping into a mysterious source of unsuspected energy? In the U.S. patent—even in *claim* #10 *explicitly*— is the assertion that there is enough electric energy output to tap some of the electric power out to run the gas-producing part.

Among the basic properties of AquaFuel: It is lighter than air—easily seen when a balloon or sealed plastic "garbage bag" is filled with it; The gas does not self-combust, because of the extremely low oxygen content (on the order of only one-percent). It is not "Brown's Gas" nor anything remotely like the hydrogen and oxygen mix from ordinary electrolysis. The closest cousin of this gas might be so-called "water gas" or "blue gas," which is prepared by placing water on red-hot coals.

On November 3, 1995, the Materials Science Division, Materials and Chemical Analysis Branch, at the Kennedy Space Center in Florida determined these volume percentages in an AquaFuel sample sent in a 500 ml stainless steel bottle. They used a Carle Gas Chromatograph:

(Report #95-1C0632)

	%
Hydrogen	46.483
Carbon dioxide	9.329
Ethylene	0.049
Ethane	0.005
Acetylene	0.616
Oxygen	1.164
Nitrogen	3.818
Methane	0.181
Carbon monoxide	38.370
Total	100.015

Even without any over-unity, there is no doubt that the fuel has some unusual properties. It is composed largely of H_2 gas and CO, a very small amount of oxygen, and other hydrocarbons. It is lighter than air. It is extremely simple to produce, yet it runs internal combustion engines with virtually no significant retrofit modifications. Take a small two to five horsepower lawnmover engine, rip the carburetor off, and feed in AquaFuel with a 3:1 to 5:1 air/fuel mixture, and the engine works beautifully. In fact, Richardson had the fuel tested at Briggs and Stratton in Milwaukee, Wisconsin on a 2 HP engine. Richardson presents results that indicate an astonishingly low pollutant content in the exhaust compared to a side-by-side comparison with the same type motor running on gasoline:

Briggs & Stratton test data

	Gasoline	Aquafuel
RPM	3060	3060
Torque	3.45	3.20
Horsepower	2.05	1.86
Oil Temperature	227 °F	165 °F
Exhaust Temp.	751 °F	637 °F
Hydrocarbons	2436	185 ppm
CO %	4.343	0.039
CO_2 %	12.086	14.695
Oxygen %	0.544	7.100
Hydrocarbons	13.367	0.001 g/hr !!
Nitrogen oxides	5.921	0.002 g/hr !!
CO	421.141	0.002 g/hr !!

The inventor says that this fuel burns cleaner than any known fossil fuel. Certainly, there is no sulfur dioxide produced. Bill Richardson compresses Aquafuel into tanks (typically, the kind used by scuba divers, pressurized to 2,500 psi) and uses it in various applications. It is easy to power an automobile with it. A 1986 Ford *Escort* with its gasoline tank and all emission-control equipment was powered by one such compressed gas tank, in a video tape shown to me. The company promotional literature states:

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"With AquaFuel, cars may some day be able to simply fill-up with non-flammable water and carbon, with no danger of sills, fire, and explosions. AquaFuel may eventually be produced on-board and only when needed to power the engine."

The company literature suggests this mechanism: "The 5,000 - 7,000 °F heat of the arc dissociates nearby water molecules into hydrogen and oxygen atoms. Carbon atoms break loose from the electrodes to form bonds in this high energy plasma soup. The resulting hydrogen/carbon/oxygen molecules cool and bubble up in the surrounding water....The arc appears to unlock the latent heat energy stored in all water in the form of hydrogen and oxygen atoms, while the carbon atoms provide the glue to stabilize the newly formed syngas molecules."

The gas composition may be more complex than earlier noted, says Richardson. A mass spectrometer was used, he says, to detect the mass number of constituent molecular species. High mass number peaks were seen ranging from 119 up to 976 (the instrument did not record species beyond this). He notes, "Obviously the mass spectrum raises many questions, especially since this is a reflection of the components of a lighter than air gas, i.e. AquaFuel and the mass spectrum molecular weights conclusion must inevitably be that AquaFuel is a mixture of many molecules based on hydrogen-carbon-oxygen relationships and is not a blend of simpler or essential gas components as some critics would like to imagine."

Forgetting for the moment the possibility of unusual over-unity physics here, what are the energy economics of the fuel? Richardson makes the following comparison from data to produce the 80 ft^3 of gas:

AquaFuel

Carbon used in 80 ft^3, one pound	$0.30
Two pounds of water consumed	0.10
One kilowatt-hour of electricity	0.08

BTUs in 80 ft3 of AquaFuel:
134,000 BTUs, minimum estimated

Therefore, one-million BTU's of AquaFuel cost	$3.58

Conventional Fuels

With oil costs at $17.50/barrel:

gasoline (8.6 gal = 106 BTU)	$10.32
Natural gas	$9.55
Electricity	$25.49

Conclusion: The economics look outstanding, provided that it really takes only 1 kW-hour to produce 80 ft^3 and the energy content of the 80 ft^3 gas is 134,000 BTU. To support the latter energy content, Richardson notes that the gas combined with pure oxygen in a cutting torch will easily cut steel, as an acetylene torch will.

What about any possible over-unity in the production of AquaFuel— beyond conventional physics? That can only be answered by a rigorous measurement of input energy and output electrical and thermal energy, as well as taking into consideration the chemical energy available in the combustion of about one pound of carbon to form the 80 ft^3 gas volume. More on this in the next issue of *IE* after tests are completed.

Do it—please!

Write a letter about cold fusion and new energy to your Congressman, Senator, President, favorite Presidential Candidate, or Prime Minister.

The Richardson U.S. Patent for Aquafuel, #5,435,274, July 25, 1995

ELECTRICAL POWER GENERATION WITHOUT HARMFUL EMISSIONS

Inventor: William H. Richardson, Jr., 1496 Giles St., Palm Bay, Fla. 32907
Appl. No.: 162,342
Filed: Dec. 2, 1993

Related U.S. Application Data

Continuation-in-part of Ser. No. 854,938, Mar. 20, 1992, which is a continuation-in-part of Ser. No. 613,094, Nov. 15, 1990, abandoned.

Int. Cl.6..... F02B 43/08
US. Cl... 123/3; 123/DIG. 12
Field of Search...123/3, DIG. 12

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Attorney, Agent. or Firm—Charles A. McClure

ABSTRACT

Method of generating electrical power without emission of harmful substances from combustion of a water-derived fuel gas mixture. An underwater carbon arc operated in the absence of hydrocarbons results in a mixture of gases, being non-self-combustible but combustible as a fuel gas in the presence of air, and comprising gaseous hydrogen in major amount and carbon oxides in minor amount, mainly carbon monoxide. The fuel gas is adapted, along with air, to run an internal combustion engine driving an electrical generator and so to provide useful electrical power without the harmful emissions usual in combustion of fossil fuels.

12 Claims, 3 Drawing Sheets

ELECTRICAL POWER GENERATION WITHOUT HARMFUL EMISSIONS

This is a continuation-in-part of my patent application Ser. No. 07/854,938 filed 20 Mar. 1992, which is incorporated herein by reference, and which was a continuation-in-part of my now abandoned patent application Ser. No. 07/613,094 filed 15 Nov. 1990.

TECHNICAL FIELD

This invention relates to the generation of electrical power without production of harmful emissions encountered in conventional generation of electrical power from fossil fuel combustion.

BACKGROUND OF THE INVENTION

At suitable geographical sites, generation of electrical power can be accomplished—more or less economically— by converting energy available from stream-collected rainfall, tidal, or solar sources, substantially free of harmful emissions. More usually, electrical power is generated through combustion of fossil fuels, whether in gaseous, liquid, or solid form (e.g., natural gas, gasoline, coal), but such fuel combustion is accompanied by harmful emissions, also in gaseous, liquid, or solid form (e.g., nitrogen oxides, sulfurous acid, carbonaceous particulates). Carbon monoxide, often present as a harmful emission in the effluent from combustion of a fossil fuel, is so readily oxidizable that—when a fuel—it

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converts readily and substantially completely to harmless carbon dioxide upon combustion.

Incompletely combusted carbonaceous fragments or fossil fuel combustion by-products—whether gaseous, liquid, or solid—can be directly injurious to health of humans and other living creatures, as when breathed or ingested in or with food, and can be indirectly deleterious, as by altering characteristics of the biosphere upon which all living creatures depend. Polluting emissions, from fossil-fueled factories and vehicles supplement those from electrical power plants, so there is an extreme need for both stationary and mobile power generation by alternative fuels whose combustion does not emit harmful gases, liquids, or solids. Combustion products considered harmless (as compared with aforementioned or other harmful examples) are notably carbon dioxide (gaseous) and water (gaseous or liquid).

Hydrogen, which has long been considered likely to be an ideal fuel because it converts completely to water in ordinary air combustion, is not satisfactory as fuel for internal combustion engines because it heats intake valves so hot that pre-ignition flashback occurs ahead of the combustion chamber, forming harmful nitrogen oxides then exhausted as emissions. See, to this effect, HYDROGEN STORAGE AND UTILIZATION IN TRANSPORTATION VEHICLES—SUMMARY, which was published in 1988 by the Alternative Fuels Utilization Program of the Office of Transportation Systems in the U.S. Department of Energy, including citation of other pertinent references.

SUMMARY OF THE INVENTION

A primary object of the present invention is electrical power generation without producing harmful emissions in the process.

Another object of this invention is to drive electrical generating equipment by motive means energized by air combustion of fuel without producing harmful gaseous, liquid, or solid emissions.

A further object of the invention is to generate, on-site, an electrical generator fuel free of harmful emissions when combusted.

Yet another object of this invention is to do the foregoing at either stationary or mobile electrical power generation sites.

A still further object of the invention is to save money while generating electrical power from fuel free of harmful emissions. In general, the objects of the present invention are attained by running motive means, such as an internal combustion engine, on fuel comprising in major part hydrogen and in substantial minor part carbon monoxide so as to drive an electrical generator therewith.

More particularly the fuel comprises about five to seven tenths hydrogen and about two to three tenths carbon monoxide. Only added air is required to combust the mixture to water and carbon dioxide. Internal combustion engines so fueled operate normally and are free of the polluting emissions from fossil-fueled electrical generation.

The fuel is derived from electrical carbon arcing under water. The negative voltage coefficient of resistance characteristic of an arc ensures that, once struck, the arc persists at negligible power consumption—and, provided with carbon, can be maintained by a fraction of the output of the generator driven by an engine so fueled.

Other objects of the present invention, together with means and methods for attaining the various objects, will become apparent from the following description and an accompanying diagram of a preferred embodiment, presented here by way of example rather than limitation.

SUMMARY OF THE DRAWING

FIG. 1 is a schematic diagram of an exemplary embodiment of the electrical power generation apparatus of this invention, including related fuel-producing equipment;

FIG. 2 is a fragmentary perspective view, on an enlarged scale, of the carbon arc and vicinity in the same apparatus; and

FIG. 3 is a schematic block diagram of production of the fuel and generation of electrical power therefrom.

DESCRIPTION OF THE INVENTION

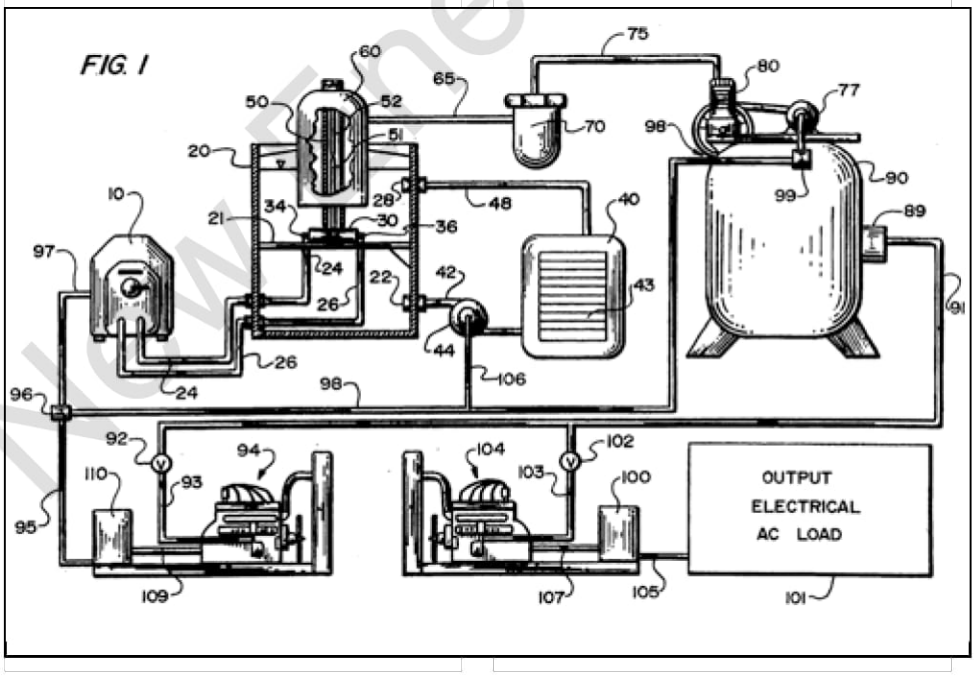
FIG. 1 features welder 10 as a high-current electrical power source suitable for striking an underwater carbon arc in open-top reactor 20. Pair of electrical leads 24, 26 go from the welder to and through the sidewall of the reactor and connect at terminals 34, 36 across block electrode assembly 30 supported level on partition 21. Reactor 20 contains water (dashes) to a level (triangle) covering not only the electrode assembly but also outlet 22 (near bottom) to water line 42 containing filter/pump 44 and leading to heat exchanger 40 (mostly hidden behind louvers 43) and back to inlet 28 (near top) at the end of return line 48 from the heat exchanger.

Open-top magazine 50 and surrounding closed-top gas collection hood 60, suitably supported, extend downward into the reactor from and terminate (open downward) under water just above block electrode assembly 30. Carbon rods 51 and 52, aligned upright within the magazine, are centered above the electrode assembly, with the bottom end of the first rod bridging the narrow edges of the respective electrodes (shown later) and with the bottom end of the second rod resting on the top end of the first rod. Gas fuel takeoff line 65 connects the interior of hood 60 to filter 70, from which gas collection line 75 connects to storage tank 90 via compressor 80 driven by motor M, both located on top of the storage tank.

The rest of FIG. 1 shows pressurized fuel tank outlet valve 89 at the right, connecting the tank through valve 92 to fuel line 91. This fuel line connects via branch lines 93 and 103, containing respective valves 92 and 102, to motive means in the form of pair of internal combustion engine assemblies 94 and 104. Shaft 109 from engine 94 connects to generator 110 (shown in block form), whereas shaft 107 connects to similarly shown generator 100 by shaft 107.

Pair of output electrical leads 95 from left generator 110 go to multi-position junction switch 96, from which separately switched (i) pair of leads 97 go to welder 10, and (ii) pair of leads 98 go to compressor 77 via pressure-switch junction 99 and (iii) by branch leads 106 to circulating pump 44. These leads conduct DC or single phase AC power, as most appropriate for the intended internal uses. Trio of output leads 105 from right generator 100 conduct three-phase power to block 101 designated as Output Electrical AC Load. The respective engines and their associated generators may take the well known compact form of motor-generator assemblies; alternative motive means may include burners and/or boilers heated by combustion of the fuel, plus engines actuated by the burning gases or by steam.

FIG. 2 shows fragmentarily, in perspective, block electrode assembly 30 on partition 21 of the reactor (as in FIG. 1 but larger). Central opening 35 in the com-



New Energy Times Archive

partment is as wide as the spacing between the narrow edges of respective wedge-shaped electrodes 31, 32. The rounded lower end of rod 51 is nearing the opening, which it will bridge as the arc is struck across the electrodes and through it when power is applied across the electrodes at terminals 34, 36. Water is omitted as unnecessary to an understanding of this view, but it will be understood to be present, with the further understanding that an arc struck between the underwater carbon electrodes and through the carbon rod heats the water drastically and decomposes it into constituent hydrogen and oxygen and also that the oxygen reacts with carbon to produce gaseous carbon monoxide and carbon dioxide. The next view will aid understanding of the ensuing procedure, both the steps giving rise to the fuel production, and the subsequent steps of converting the fuel with air into output electrical energy.

FIG. 3 shows, in block form, a flow diagram of steps that take place in the practice of this invention. The fuel generation steps predominate in the upper part of the view. The fuel conversion and power generation steps predominate in the lower part of the view.

Sequential steps in the fuel generation part of this invention include (1) TURN ON HIGH CURRENT POWER SUPPLY, (2) START ARC UNDER WATER, (3) FEED CARBON RODS, (4) EVOLVE GASES, (5) COLLECT GASES, (6) FILTER OUT CARBON PARTICLES, (7) COMPRESS FUEL GASES, and (8) STORE COMPRESSED FUEL. The last two mentioned steps are performed upon the evolved, partly reacted, mixture of constituent Andy by-product gases. Accessory composite steps (9) COOL AND FILTER WATER maintain water conditions as desired, especially at the hot underwater arc locus of gas evolution-from which evolved gases bubble up through the intervening water, heating it, and into the overlying hood, to be drawn off and stored for fuel use as indicated.

Sequential steps in the center of FIG. 3 include arrows and lines from the Store Compressed Fuel step downward to the lower part of the view, and a pair of symmetrically located steps, (16) COMBUST MINORITY OF FUEL (at left) and—at right—(11) COMBUST MAJORITY OF FUEL. Succeeding the latter step are the sequential steps of (12) DRIVE MAJOR GENERATOR, (13) GENERATE EXTERNAL 3-phase AC. A final arrow on the right terminates at (14) EXTERNAL LOADS. To the left from the step (15) COMBUST MINORITY OF FUEL are the sequential steps of (16) DRIVE MINOR GENERATOR and (17) GENERATE INTERNAL AC/DC terminating at (18) INTERNAL LOADS.

Practicing this invention is readily apparent from FIGS. 1 to 3 and the foregoing description. Underwater arcing occurs when an electrical potential (AC or preferably DC) such as common in steel welding is applied across the block electrodes, which preferably are composed essentially of graphite-preferably with a conductive rod (itself mainly carbon) substantially bridging the gap between them.

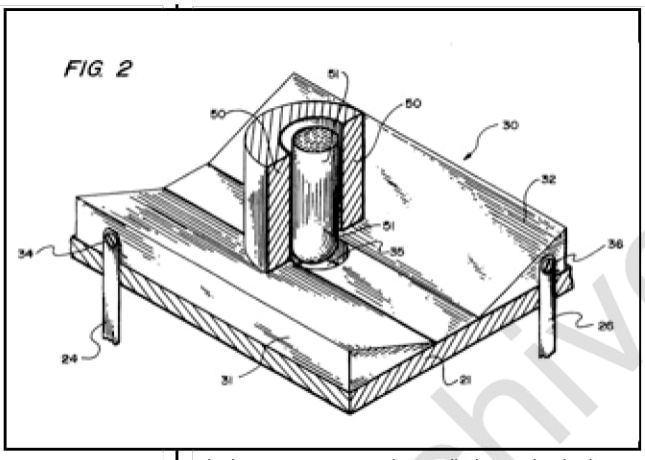
Precisely what happens in arc-induced decomposition of water is not well understood, though the resulting fuel and its combustion products have been ascertained. To the extent that this specification interprets decomposition or combustion processes, or accounts for the presence of certain products and absence of others, it is to be understood as theoretical or academic rather than definitive.

The mixture of gases so evolved and collected according to the present invention contains (by volume) gaseous hydrogen in major amount, such as from about five to about seven tenths, and carbon monoxide in substantial minor amount, such as from about two to about three tenths. Up to about a tenth to an eighth of the mixture may be made up mainly of carbon dioxide and to a minor extent of gaseous oxygen—the latter in an amount insufficient for the mixture of gases to be self-combustible (rarely more than several percent).

A representative analysis of the fuel gas of this invention can be expected to show about five-eighths gaseous hydrogen, two eighths carbon monoxide, with the rest made up of the other mentioned gases.

Oxides of nitrogen and sulfur common in combustion products of gases from fossil fuels and in hydrogen combustion are missing or minimal because, first, there is no possible source other than air or water and, second, the carbon monoxide content effectively cools and evens out the hydrogen combustion so as to preclude its usual intake valve overheating, plus flashback and hyperoxidative effects.

The carbon dioxide content is held down by substantial absence of hydrocarbons, oils, or other organic chemicals, such as otherwise might combine with the oxygen released by water decomposition in the reactor. The modest amount of resulting gaseous oxygen in the fuel of this invention may have been dissolved in the water initially.



Carbon in the resultant gaseous mixture preferably comes mainly from the rod used to bridge the block electrodes. Alternatively it may be fed to the arc site in particulate form with like effect.

The resulting fuel gas burns upon access to air in effective amount, evenly with substantially clear flame and no sooting. In its gaseous state it can fuel an internal combustion engine without need for an atomizing carburetor or injection nozzle. Such engine may be of jet, piston, turbine, or other type. With an interposed boiler, steam may be generated from water for turbine engine use.

The water to be decomposed in the process of this invention is not subject to any unusual requirement, and most fresh water sources can be expected to prove satisfactory, or salt water can be used. Content of petroleum products or other organic materials should be avoided as they might contaminate the resulting fuel gas.

No unusual materials of construction are needed in apparatus of this invention. The reactor need be only a structurally sound tank, such as steel or other metal, and is preferably grounded. The hood to receive the evolved gases, and the magazine to hold and dispense the rods, are conveniently made of metal, plastic, or ceramic. The magazine may accommodate any convenient number of rods, conveniently loaded upright side-by-side on an inside surface slanting down to an exit directly above the desired electrode-bridging location so as to [be] fed by gravity, although automatic feed may be adopted if preferred.

The rods themselves may be common welding rods, composed mainly of particulate carbon held together by a conventional binder. As also noted, the electrode blocks are solid graphite, also generally available for use in welding and other high-temperature environments and/or high-pressure environments requiring chemical inertness.

The toxicity of carbon monoxide should not pose any problem. Caution is essential in the handling and use of any fuel, so it is expected to be exercised in the instance of this fuel gas as well.

The combustion products of gaseous hydrogen and carbon monoxide are respectively simply water and carbon dioxide, so clean burning is an understandable characteristic of the resulting fuel gas, as is the preference for exclusion of organic materials generally. Other advantages include the fact that water and carbon are relatively low-cost inputs. Similarly, the power required to decompose water is readily available at reasonable cost in at least most locations.

The electrical potential applied across the underwater arc is preferably DC (direct-current) rather than AC (alternating current). Conventional welding equipment operates from standard line-power AC (usually 3-phase) input, and yields a DC or AC output, as desired. For present purposes a DC output of at least several dozens of volts across the electrodes is preferred. External rectification of AC is readily accomplished, as in welding apparatus, for example. AC to DC conversion without moving parts and with an improved output may be accomplished according to Luce U.S. Pat. No. 4,870,558.

If a conventional power source is objectionable because dependent upon fossil fuels, part of the electrical power output can be applied to maintain the arc, and a small part can even be stored, as in a battery or a large capacitor, to restart the arc at any time. Motive means to be actuated by combustion of the fuel, whether directly by resulting temperature increase and associated expansion in volume, or indirectly by conversion of water to steam and similar use of the change-of-state volume expansion, may be conventional. A conventional motor-generator may be used as both motive means and electrical generating means, as its name suggests. Three-phase and single-phase AC motor-generator outputs are available. DC output can be provided by rectifying AC output, preferably without adding moving parts. Motor generators are readily available with multi-phase output (AC). Single-phase AC generators are available, some with optional DC.

The external electrical loads may be any downstream electrical equipment external to the system. The internal electrical loads include the water cooling means, water circulating means, and gas compressing means—and may include the arc as well, once the arc is operating so as to make the system self-contained.

It should be understood that this invention provides a key to unlocking stored chemical energy by applying considerable electrical energy for a very short time and a smaller amount for a much longer time, and by adding chemical energy in the form of cheap carbon, air, and water to obtain more (and more valuable) electricity. This method should not be understood as violating any accepted scientific principle, but only as applying science to economic advantage, as facilitated by the negative voltage coefficient of electric arcs.

The accepted view of internal combustion engines as inefficient should be substantially redirected to the combustion inefficiency of fossil fuels. The fuel of the present invention greatly improves engine operation and benefits the environment by absence of the customary polluting emissions. These benefits are attributable mainly to the increased efficiency of combustion of this fuel supplemental to the minimal power requirement for converting inexpensive input materials into the fuel itself

Preferred embodiments and variants have been suggested for this invention. Other modifications may be made, as by adding, combining, deleting, or subdividing compositions, parts, or steps, while retaining all or some of the advantages and benefits of the present invention—which itself is defined in the following claims.

I claim:

1. Method of generating electrical power from fuel combustion, comprising the steps of

operating motor-generator apparatus,

including inter-nal-combustion means and electrical-generating means, with compressed fuel comprising by volume about five-tenths to about seven-tenths hydrogen and about two-tenths to about three-tenths carbon monoxide,

including combusting the fuel substan

tially entirely to water and carbon dioxide in the internal-combustion means to drive the electrical-generating means.

2. Method according to claim 1, including the steps of deriving the fuel from water by operating an underwa-

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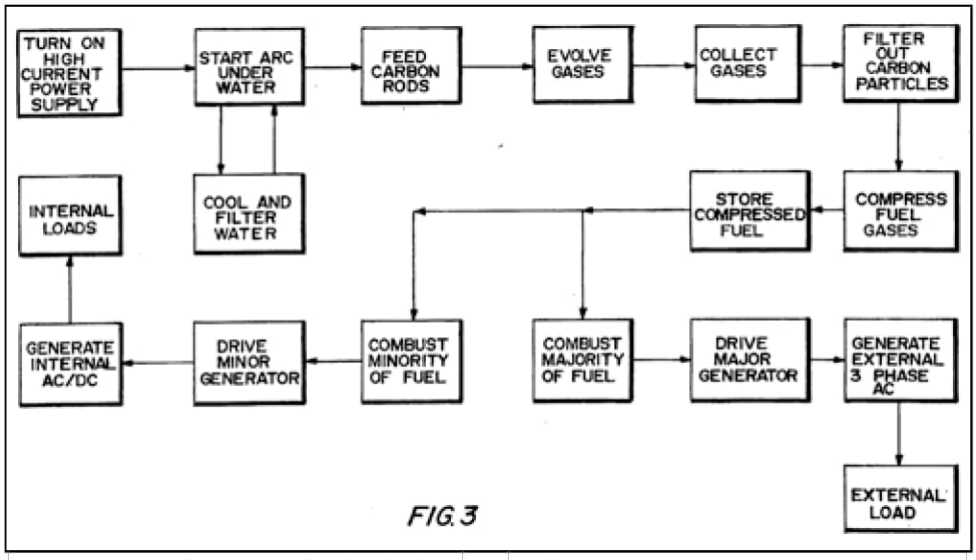

FIG. 3

ter carbon arc, evolving and collecting the fuel therefrom in gaseous form;

feeding the fuel to the motor-generator's internal combustion means along with sufficient air to combust the fuel,

so operating the internal-combustion means to drive the electrical-generating means; and

generating electrical output power with the electrical-generating means.

3. Method according to claim 2, including feeding carbon to the arc during operation, in accordance with consumption thereof.

4. Method according to claim 3, including the steps of compressing and storing for future use fuel so collected, and recirculating some water from the vicinity of the arc through a filter to clean it and through a heat exchanger to cool it.

5. Method according to claim 4, including the steps of using minor amounts of the generated electrical power to perform the fuel compressing and storing steps and the water recirculating step.]

6. Method according to claim 2, including the step of striking the arc initially from an external source of electrical power.

7. Method according to claim 6, including the step of maintaining the arc with a minor amount of the generated power.

8. Electrical power generating system comprising fuel combustion means adapted to intake air and air combustible fuel and to combust the fuel with the air and in so doing to emit water and carbon dioxide and to actuate associated motive means adapted to drive interconnected electrical generating means;

motive means associated with the fuel combustion means and actuated by the combustion thereof to drive the generating means;

electrical generating means mechanically connected to the motive means and thereby adapted to be driven thereby to generate electrical power as the output of the generating means; and

fuel-evolving means comprising an underwater arc having carbon electrodes and adapted to evolve fud comprising about five-eighths hydrogen and about three-eighths carbon monoxide by volume, plus fud-compressing means adapted to provide the combustion means with said compressed fuel, air-combustible without harmful emissions.

9. Electrical generating energy-conversion method, comprising

supplying a container with water,

immersing in the water in the container carbon electrodes adapted to arc therebetween when sufficient electrical potential is applied thereacross,

placing gas-collection means over the carbon electrodes and extending below the water surface in position to receive gas evolved incident to decomposition of water by operation of the electric arc;

applying across the carbon electrodes an electrical potential effective to decompose water into its component gases, hydrogen and oxygen and to oxidize carbon, thereby evolving hydrogen in major part and carbon oxides in substantial minor part, mainly carbon monoxide and partly carbon dioxide

collecting and storing the evolved gases under pressure;

feeding the evolved gases as fuel along with air to combustion means adapted to combust hydrogen to water and carbon monoxide to carbon dioxide and thereby to raise their temperature and to expand their volume;

operating motive means with the heated and expanding gases;

driving electrical generating means with the motive means and thereby generating useful electrical output.

l0. Energy conversion method according to claim 9, including applying part of the generated electrical output to the carbon arc electrodes, and thereby enabling continued operation of the arc and the rest of the method independently of external power sources once the arc has been struck and electrical output has been generated.

11. Energy conversion method according to claim 10, including storing part of the generated electrical output in suitable means from which it can be recovered at will.

12. Energy conversion method according to claim 14, including applying the stored electrical output to the carbon arc electrodes, and thereby re-initiating the arc after any discontinuation thereof. •

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A Prophecy

"...water decomposed into its primitive elements...and decomposed doubtless by electricity, which will then have become a powerful and manageable force...I believe that water will one day be employed as a fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable. Some day the coalrooms of steamers and the tenders of locomotives will, instead of coal, be stored with these two condensed gases, which will burn in the furnaces with enormous calorific power...I believe, then, that when the deposits of coal are exhausted, we shall heat and warm ourselves with water. Water will be the coal of the future."

Jules Verne, ca 1870,
The Mysterious Island

New Energy Times Archive

Table-Top Antigravity?

by Chris Tinsley

Some of our readers may have seen some references to 'antigravity' in the press recently and, since I have been keeping an eye on the subject, our Gentle Editor has asked me to make a short summary of the story so far.

It's all rather embarrassing because all this has been going on under our noses for several years, and yet we were not really paying much attention until one of the best science journalists in the UK, Robert Matthews, covered it in the *The London Sunday Telegraph* (September 1, 1996, page 3).

The article had two authors: Matthews, and Ian Sample —who is an editor of *Journal of Physics-D: Applied Physics*. This reputable journal had peer-reviewed and accepted a paper by Eugene Podkletnov and Petri Vuorinen of Tampere University in Finland, a paper which claimed that if a disk or ring of superconducting material were spun while supported by a magnetic field, the weight of an object placed above it could be reduced by as much as 2%.

Breakthrough as scientists beat gravity

by ROBERT MATTHEWS and IAN SAMPLE

SCIENTISTS in Finland are

HOW THE ANTI-GRAVITY DEVICE WORKS

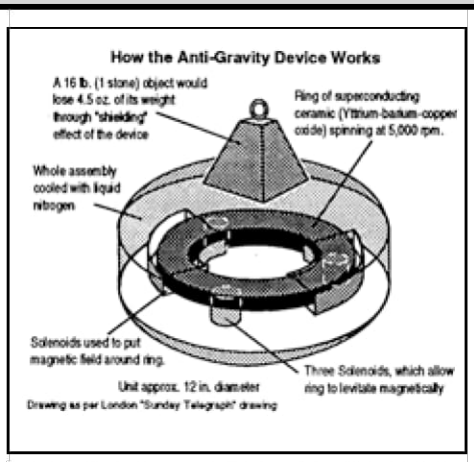
A 16lb. (1 stone) object would lose 4.5 oz. of its weight

Ring of super conducting ceramic (Yttrium-barium-copper oxide) spinning at 5,000 rpm.

So far, so good. But Tampere promptly responded to this article by saying that Podkletnov was not really an active member of the University, and a Petri Vourinen also responded by denying that he had co-authored the paper! All was not well in this affair, it would seem. Matthews investigated all this, and got some rather odd statements from Podkletnov — including the assertions that there was some confusion over the name of his co-worker, and that the work reported did in fact date back to 1992.

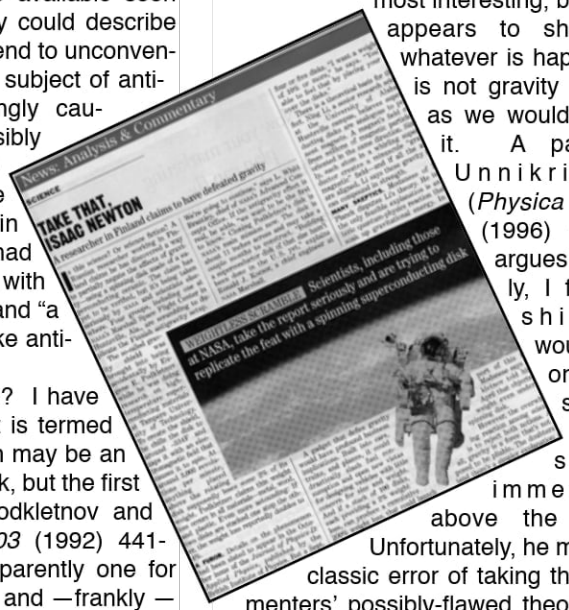
Newspapers are rarely enthusiastic about going back over their more sensational articles, just as in the case where a news magazine accused Dr. John Bockris or his graduate students of fraud over his CF tritium results—but did not want to report on the 120 papers which later confirmed his work. So, *The Sunday Telegraph* did not print Matthews' follow-up article, and instead he published a report in *New Scientist* (September 21, 1996 page 7). By this time, Podkletnov had withdrawn his *J. Phys. D.* paper, claiming that his financial backers did not want it published.

Business Week then published an article (September 30, 1996, p.42.) by Otis Port, summarizing the situation to date.



Redrawing, courtesy Fusion Information Center

All heady stuff! Trying to pick through the fog of accusations, muddled thinking, dubious experimental technique, false assumptions and the impenetrable thicket of mathematics in the theory papers has been quite a task. Just about all I can do to help is to examine the actual published papers on the subject. But, before doing that, I am reminded of what Professor Frank Close, Head of Theoretical Physics at the Rutherford Appleton Laboratory said on the recently shown BBC TV series *Future Fantastic* (made in collaboration with *The Learning Channel*, so it should be available soon outside the UK). Nobody could describe Dr. Close as being any friend to unconventional science, yet on the subject of antigravity he was surprisingly cautious. He said that possibly antigravity was closer to science fact than one might think, and that in some theories gravity had two components - the one with which we are all familiar, and "a little bit on top, which is like antigravity."


News: Analysis & Commentary

SCIENCE

TAKE THAT, ISAAC NEWTON

A researcher in Finland claims to have defeated gravity

WASHINGTON, D.C. & BAMBERG

Scientists, including those at NASA, take the report seriously and are trying to replicate the feat with a spinning superconducting disk

But what of the papers? I have seen discussions of what is termed the "Hooper Effect," which may be an early precursor to this work, but the first paper I have is from Podkletnov and Nieminen (Physica C *203* (1992) 441-444). This journal is apparently one for superconductor research, and —frankly — this paper isn't a very good one. One serious criticism is that there are no clear explanations of how the 'weight loss' was measured, nor are there any error bars associated with the claim of 0.5% weight loss of small samples placed above the device. Another problem is that there seems to be a lot of irrelevant talk about superconductors, but the worst error is the assumption that this is a form of "gravity shielding." Perhaps this is deliberate, nobody wants to use the "'A' word"! The paper begs far more questions than it answers, but perhaps I can summarize the "good bits."

The test involved a six-inch disc of superconductor ($YBa_2Cu_3O_{7-x}$), about one-quarter inch thick. It was raised above a liquid helium bath using solenoids, and was spun in the same way. During the time it stayed cold enough (below 70K) it reduced the weight of a sample of silicon dioxide (glass or quartz) by 0.05%. Various precautions were taken to prevent error, but it isn't really clear how good they are.

While we do not have a copy of the paper accepted by *J. Phys. D*, we do have a 1995 report (Tampere University Press) from Podkletnov and Levit (MSU-95 chem). This reports an essentially similar experiment, one which claims an effect of 1.9% - 2.1% at maximum. In this case, a torus was used, inner diameter 80mm, outer diameter 275mm and thickness 10mm. Test materials included metals, glass, plastics and wood; typically of mass 10 to 50 grams. The effect was noted at heights above the apparatus of between 25mm and 1500mm. That latter figure is most interesting, because it appears to show that whatever is happening it is not gravity shielding as we would imagine it. A paper by Unnikrishnan (*Physica C* 255 (1996) 133-137) argues (correctly, I feel) that shielding would affect only a short cone of space immediately above the gadget. Unfortunately, he makes the classic error of taking the experimenters' possibly-flawed theory, trashing that, and concluding that the results cannot be real.

New Energy Times Archive

of taking the experimenters' possibly-flawed theory, trashing that, and concluding that the results cannot be real.
The Tampere report continues:

"The levitating superconducting ceramic disk revealed clearly visible shielding effect against the gravitational force even without rotation. The values of the weight loss for various samples were within the range 0.05% - 0.07%. As soon as the main solenoids were switched on and the disk began rotating in the vapors of liquid helium, the shielding effect increased, and at the speed of 5000 rpm, the air over the cryostat began to raise slowly up to the ceiling. The particles of dust or smoke made the effect clearly visible. The boundaries of the flow could be seen clearly, and they corresponded exactly to the shape of the toroid. The weight of the various samples decreased no matter what material they were made of. The loss of weight depended on the shape and the position of the sample. The maximum loss of weight could be reached if the sample was oriented with the flat surface parallel to the surface of the disk, so that the projection of the sample had the maximum area."

Podkletnov claims that vertically stacking *two* 2%-reduction devices leads to a 4% reduction in weight of objects above.

Moving to the theory papers, there are several by Torr and Li which appear in reputable journals such as *Physical Review*. These appear to lend support to the experimental results.

Our conclusion? Well, this has been described as "high risk, infinite reward" physics. Certainly it is not anything which we would recommend as an investment opportunity! However, this magazine can do as it wishes with its tiny funds, so we have made a no-strings grant of $1,000 to one researcher who is diligently attempting to reproduce and perhaps even improve on the Podkletnov results. In fact, four known groups—even one at NASA's Marshall Spaceflight Center—are trying to duplicate the Finland experiment. Whit Brantley, chief of NASA's Advanced Concepts Office in Alabama, is on record in *Business Week* with full support of efforts to replicate antigravity.

Watch this space.

RECENT ANTIGRAVITY TECNICAL REFERENCES:

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C.S. Unnikrishnan, "Does a superconduc-

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The Journal of the Scientific Aspects of Loading Isotopic Fuels Into Materials

Published Quarterly

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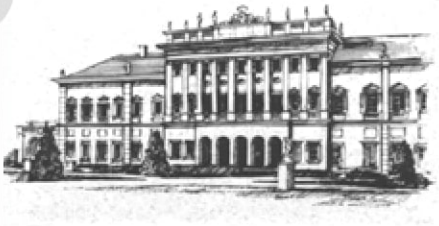

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Plant Power for Power Plants?

Has Nature magazine (and many others) been duped by a magician?

An amazing claim has come out of India in recent weeks: that an extract of a certain plant growing in India is able to change water to a hydrocarbon fuel! Almost as surprising, journals such as *Nature* have given this claim serious non-dismissive attention, because credible scientists who have witnessed the process believe that it is real! The following story appeared in the *Times of India*, dated Friday September 6, 1996, page 16:

"Herbal petrol" invention sets scientific community afire

New Delhi, September 5. —A high school dropout from Tamil Nadu created history here on Wednesday when he turned water into a petrol-like fuel by mixing it with a herb he discovered in the hills.

Scientists witnessing his demonstration at the Indian Institute of Technology (IIT) said they were baffled. "It is incredible but true," exclaimed IIT chemist N.K.Jha who organised the experiment at the request of the department of science and technology (DST).

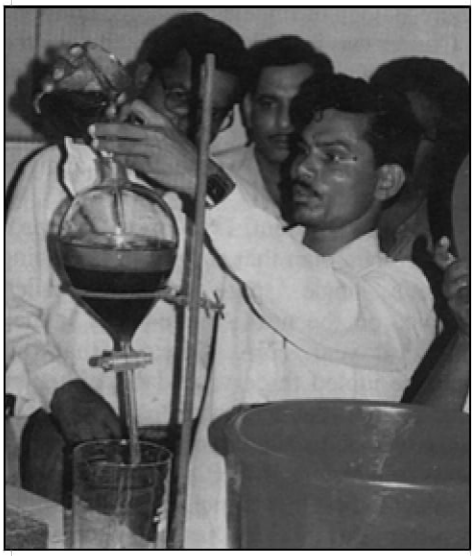
In plain terms, this discovery means that given the herb you can convert tap water into a fuel that can drive your vehicle. In fact 30-year-old Ramar Pillai who discovered the amazing herb seven years ago has been doing precisely that in his village near Rajapalayam.

Mr. Pillai, who was invited to Delhi by DST secretary Yalangiman Ramamurti, says his herbal petrol would cost one rupee per litre [Ed. Note: 1 rupee = three U.S. cents.] All he wants from DST is money to put up a plant in his native place and personal protection.

He recently had an attempt on his life for refusing to part with his secret.

"I am personally convinced is is a discovery worth pursuing," said Mr. Ramamurti after repeating the experiment himself. The product burnt with a sooty flame, smelled like kerosene, and on distillation yielded a pure hydrocarbon fraction with a boiling point of 170 degrees centigrade.

"We have no doubt that we are sitting on something very big," Mr. Ramamurti said, "but we must proceed carefully and systematically."



Inventor Ramar Pillai of Tamil Nadu demonstrating the conversion of water into petrol using a secret herb at the Indian Institute of Technology at Delhi. (Courtesy, K.S. Jayaraman)

He said DST has assigned the highest priority to get Mr. Ramar's invention patented. The department has also acceded to his request for funds to create a 300 litre per day pilot plant at Rajapalayam.

Simultaneously the best scientists in the country are going to be assembled to understand the chemical process in detail before setting up a plant with a production capacity of one million liters per day, Mr. Ramamurti said. Defence Science adviser A.P.J. Abdul Kalam has been briefed and he is reportedly "excited."

Mr Ramamurthi said the economic implication of his discovery for the country being so enormous, he has decided to keep science minister Yoginder Alagh and the office of Prime Minister H.D. Deve Gowda informed about the developments.

As an eighth class student Mr. Ramar realised the value of the plant during a picnic in a forest when a flying spark from the cooking stove set a leaf of a nearby plant on fire.

He almost forgot about this strange event of a green leaf catching fire but ten years later he tracked down the plant and started experimenting with it.

To produce petrol, leaves and barks of this plant are cooked for about ten minutes in hot water. The mixture is cooled and stirred after adding a little salt, citric acid and traces of a few unknown chemicals. Once allowed to settle, the liquid fuel, which is lighter than water, floats to the top and is separated by filtering. The entire process takes less than 30 minutes.

According to DST, laboratory tests conducted with earlier samples have conclusively shown that the herbal fuel is a pure hydrocarbon similar to kerosene and diesel.

••••••END of TOI Article•••••

Additional details appeared in *Nature*, Vol. 383, 12 September 1996, p.112:

• 55 grams of leaves and bark of the bush-like plant are combined with 1,000 milliliters of water. A bit over 30 minutes later, 460 milliliters of a liquid that burns and smells like kerosene is produced. Distillation determined a boiling point of 170 °C.
• The National Chemical Laboratory in Pune determined that the product is a pure hydrocarbon—details are confidential while patents are being applied for.
•The Mechanical Engineering Dept. in Madras determined that the mileage efficiency is better than that of gasoline! There is no sulfur in the exhaust.

IE EDITOR'S COMMENT: There are so many mysteries that this "discovery" brings up—we breathlessly await reports, if any, that can legitimately debunk it. And, if it is *not* debunked: How can so much carbon be formed in the water? It is deemed implausible for it to arise from the CO_2 in the atmosphere. We will certainly be following this story with great interest! Perhaps our colleague in India, Dr. M. Srinivasan, will gather more information for Issue #10 of *IE*.

In a late-breaking development—also reported in *Nature*, we learn that researchers at the Indian Institute of Petroleum in Dehra Dun say they have confirmed the process.

The state government of Tamil Nadu granted inventor-discoverer Pillai 20 acres of land to cultivate the necessary herb. He will initially produce 50 liters per day in his basement production facility. He has also been granted the security protection that he apparently needed. (A death threat was made if he did not reveal the secret ingredient.) The product will be called Western Ghats Oil and will initially be sold at 10 Rupees/liter ($0.30/liter). By next month, the process will have been patented by the Indian Department of Science and Technology.

And now for the Bad or Good news—depending on whether you like *Nature* magazine with its atrocious conduct against cold fusion. Late breaking news is that Pillai has apparently been unmasked as an alleged magician, who has been secretly adding oil to his process—even right in front of critical scientists. Yet, *Nature* seems to have given the process very high credence. Details will follow in *IE* Issue #10. *Nature* fooled by a magician—we love it, if it's true!—*EFM*

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Mass Modification Experiment Definition Study

by Robert L. Forward, February 1996

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Sponsoring/Monitoring Agency: Phillips Laboratory, OLAC PL/RKS, 10 E. Saturn Blvd., Edwards AFB, CA 93524-7680
Phillips laboratory, Propulsion Directorate, Air Force Materiel Command, Edwards Air Force Base
Report Number: **PL-TR-96-3004**

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Editor's Note: *We are publishing this U.S. Air Force technical report by Dr. Robert L. Forward, because it offers excellent introductory material about Zero Point Energy. It also suggests a range of experiments that demonstrate macroscopic effects that ZPE can promote—including possible alterations of inertial mass. As a colleague of Robert Forward, I know that he does not necessarily "buy" the evidence for some of the macroscopic over-unity devices we report on, including "cold fusion." But give him time! (He's also an accomplished science fiction writer, so he'll soon have a lot-more to write about when O/U devices power his computer.) —* ***EFM***

ABSTRACT

The vacuum is proving to be one of the hottest topics in contemporary physics. It is a source of numerous effects: force fields that emerge from nowhere, particles popping in and out of existence, and energetic jitterings with no apparent power source. Many researchers see the vacuum as a central ingredient of 21st Century physics. Some even believe the vacuum may be harnessed to provide a limitless supply of energy. This report summarizes an attempt to find an experiment that would test the Haisch, Rueda, and Puthoff (HRP) conjecture that the mass and inertia of a body are induced effects brought about by changes in the quantum-fluctuation energy of the vacuum. However, it was not possible to identify a definitive experiment. But, it was possible to identify an experiment that might be able to prove or disprove that the inertial mass of a body can be altered by making changes in the vacuum surrounding the body. Other experiments, which do not involve mass modification, but which teach something about the vacuum, were also defined and included in a ranked list of experiments. This report also contains an annotated bibliography and a list of scientists active in the field.

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MASS MODIFICATION EXPERIMENT DEFINITION STUDY GOALS

The goal of this study contract was to define an experiment that could conclusively determine, one way or the other, whether the mass of a body could be modified by modifying the vacuum fluctuations around or in that body. If the mass of a body can be modified in even a small way, that fact will be of importance to science. If the mass of a body can be modified significantly, that fact will be of importance to Air Force missions.

The study was instigated by the conjectures by Puthoff (1989) and his colleagues Haisch, Rueda, and Puthoff (1994) that the gravitational mass and the inertial mass of a body are induced effects brought about by changes in the fluctuation energy of the vacuum when the body is present. The study was not limited to the Puthoff conjectures. Other theories concerning the various effects of vacuum fluctuations were also considered.

Puthoff, Haisch, and Rueda were contacted in an attempt to identify a definitive experiment. This requires that the theory proposed by Puthoff and colleagues make

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a numerical prediction of a specific result, and requires that the experimental apparatus have the sensitivity and precision to measure the predicted result to high accuracy. If the experimental result agrees with the theoretical prediction, then the Puthoff conjecture will have been proven to be "correct" (as much as any theory can be proven to be correct), while if the experimental result does not agree with the theoretical prediction, the Puthoff conjecture will have been conclusively proven to be wrong. Unfortunately, it was not possible to identify a definitive experiment. There are experiments presently being undertaken by Puthoff, which, if successful, will prove the Puthoff conjecture correct. The failure of these experiments to produce a result, however, will not prove the Puthoff conjecture wrong, since the theory does not give a firm prediction of the magnitude of the effect being looked for.

It was possible, however, to identify an experiment which might be able to prove or disprove that the inertial mass of a body can be changed by making changes in the vacuum surrounding the body. The theory this experiment is based upon is the well-accepted theory of Quantum Electrodynamics. Much work needs to be done, however, both on the theoretical analysis and the experimental design, before one can say if the experiment is feasible. Other experiments, which do not involve mass modification, but which teach us something about the vacuum, were also defined and included on a ranked list of experiments.

The report also contains an annotated bibliography of the publications used in preparing the report. The papers referenced in the text by an author's name and a date, refer to entries in the bibliography. The report concludes with an annotated list of those scientists active in the field of vacuum fluctuations.

RATIONALE FOR STUDY AND RECOMMENDED EXPERIMENTS

At first glance, it might seem that experiments to study the electromagnetic fluctuation energy of the vacuum are so esoteric and so devoid of practical applications that they should be funded solely by the National Science Foundation, if at all. Yet, experiments to study the vacuum could lead to real advances in space power and propulsion technology as well as expanding our knowledge of basic physics.

The situation is reminiscent of the field of nuclear energy in the 1930s. Scientists were only just beginning to understand the structure of the atom. The element radium had been purified. It violated the law of energy conservation by continuously giving off heat and radiation. It seemed to be an inexhaustible source of "free energy." Uranium, mostly used to give a "vaseline yellow" color to glass, was also known to give off radiation that would fog photographic plates.

Soon scientific knowledge increased. The atoms were a nucleus made of protons and neutrons surrounded by a cloud of electrons. The number of protons and electrons determined the element, while the number of neutrons determined the "isotope" of that element. Finally, scientists realized that the "free energy" coming from certain isotopes of radium and other elements was not really "free" at all. Instead, a small amount of mass m was being converted into large amount of energy E according to the equation $E=mc^2$, where c is the speed of light. Using this equation, "nuclear energy" could be estimated to produce $9x10^{l3}$ joules of energy per gram of mass.

Then, neutrons were found to be capable of fissioning certain isotopes of heavy elements, releasing "nuclear energy" on demand. Even then, "nuclear energy" was not considered very practical. It was thought that either gigantic "atom smashers" or large "atomic piles" would have to be constructed to obtain the "nuclear energy." It was only after much knowledge had been gained about the fission process, and much chemical engineering work had gone into isotope separation techniques, that it was finally realized that nuclear energy could be obtained from highly enriched uranium-235 or plutonium-239, by a technique as physically simple as putting in contact two precisely machined pieces of isotopically purified metal!

Thus, in just a few decades, the esoteric, poorly understood phenomena of "nuclear energy of the atom" went from being a scientific curiosity into being a major technology. In addition to weapons, nuclear energy in the form of plutonium isotopes is being used as the primary power source in NASA deep space missions. Compact nuclear reactors supply larger amounts of power for classified satellites. Nuclear electric propulsion is the technologically preferred method of sending a crewed mission to Mars, and particle bed reactor rockets would be a major component of our space defense shield if we were still at loggerheads with the USSR.

We are now in the 1990s, looking at the esoteric, poorly-understood phenomena of "electromagnetic fluctuation energy of the vacuum." We can estimate the "vacuum energy density" to be 10^{108} J/cc, and the vacuum mass density to be 10^{94} g/cc, much higher numbers than those associated with nuclear energy. In the same way that we once did not understand the atom, we presently do not understand the vacuum. We need to carry out careful experiments to accurately measure the electromagnetic fluctuations in the vacuum and how those fluctuations affect matter. That is the purpose of the two highest priority experiments. From these experiments, we expect to learn enough to propose additional experiments that will lead to a better understanding of the vacuum and how it affects the inertial and gravitational mass of bodies. This, in turn, could lead to concepts for "control" of the vacuum and control of the mass of an object. I have already shown [Forward (1984)] that it is possible to extract energy from the "electromagnetic fluctuations of the vacuum." The amount of energy that can be extracted using this technique is just a minute fraction of the 10^{108} J/cc that is calculated to be available. But as we learn more about the vacuum, it is expected that better energy extraction techniques can be found. (Perhaps a technique as physically simple as putting in contact two precisely microfabricated sandwiches of ultrafine metal-dielectric multilayers?)

One such possible energy extraction experiment is third on the prioritized list of experiments. According to our present theories about the vacuum, if we place a single proton in the center of a cold, empty vacuum chamber, then within one second that proton, driven by the electromagnetic fluctuations of the vacuum, will gain an energy of 1000 eV. Since it only cost us a few eV to ionize a hydrogen atom to obtain the proton and place the proton in the vacuum chamber, there is a substantial gain predicted. At first glance it looks like this experiment provides a source of "free energy," similar to the "free energy" that seemed to come from radium. We are sure that nature is not going to allow us to get away with this violation of the law of energy conservation. We will probably find that the energy is not "free" but is coming from somewhere else—probably from the immense energy density of the vacuum itself.

So, although the field of "electromagnetic fluctuation energy of the vacuum" is admittedly an esoteric, little-understood field, it does seem to have definite potential as an energy source. It also could have the potential of changing the mass of an object. And, since theory predicts that the vacuum has an enormous mass density as well as an enormous energy density, it might one day be possible to interact enough with the vacuum to "push" on it with a "vacuum drive." Alternatively, perhaps one day it might be possible to operate a "vacuum rocket" that uses energy obtained from the vacuum to expel reaction mass also obtained from the vacuum.

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AN INTRODUCTORY TUTORIAL ON THE QUANTUM MECHANICAL ZERO TEMPERATURE ELECTROMAGNETIC FLUCTUATIONS OF THE VACUUM

The main body of this report discusses a number of possible experiments to measure the effect of the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum on macroscopic objects. This introductory tutorial gives a short background survey of those parts of quantum theory that create in a supposedly empty vacuum, even a vacuum at zero absolute temperature, fluctuating electromagnetic radiation fields and even fluctuating numbers of charged-particle pairs. [This tutorial will attempt to explain "how," but not "why," because nobody knows why nature behaves in this admittedly strange way.]

QUANTUM MECHANICS

The well-accepted Theory of Quantum Mechanics has many aspects. The two aspects that are most important for this tutorial are that:

(1) Matter and energy are quantized.

(2) Certain types of measurements cannot be made precisely; there is always some uncertainty in the measurement. (This is called the Heisenberg Uncertainty Principle.)

QUANTIZATION OF MATTER AND ENERGY

Matter is quantized. A block of matter, although seemingly a continuously dividable substance, is ultimately found to be made up of "quanta" called atoms. An atom consists of a small massive nucleus surrounded by a large cloud of electrons. The electron cloud acts as a "spring" suspension for the mass of the nucleus, and suspends it in its place in the block of matter. This mass-spring system can vibrate. The frequency of vibration is $f=(k/m)^{1/2}$ where k is the spring constant of the electron cloud and m is the mass of the nucleus. The amplitude or energy of the vibration is determined by the temperature of the block. The higher the temperature, the more energy there is (on the average) in the vibrations of the atoms.

The energy of vibration is quantized too. The vibrational energy of the atoms come in "quanta" of energy e=hf, where f is the natural frequency of the vibration of the mass-spring system, and $h=6.63\times10^{-34}$ J•s is a very small constant called Planck's constant. These vibrational quanta have been named "phonons."

Now here comes the interesting part. When the equations of quantum mechanics are used to determine the "average energy" <E> of the vibrations of the atoms, the answer is $\langle E\rangle=[n(T)+1/2]hf$, where the number of phonons n(T) is a function of temperature such that when T=0 K, n(T)=0. Thus, even at zero temperature, quantum mechanics predicts that each of the atoms will have an average residual energy of $\langle E\rangle=hf/2$. This residual energy is an average. It is not that the energy of each atom is a "half a phonon," but that roughly half the atoms have one (perhaps more) vibrational quanta or phonons, while the others have no phonon.

The phonon distribution rapidly changes with time as the phonons are passed back and forth between the many atoms. This residual energy at zero absolute temperature predicted by the equations of quantum mechanics is the so-called "Quantum Mechanical Zero Temperature Vibrational Fluctuations of Matter."

This quantum mechanical fluctuation energy of the atoms in matter has been measured by measuring the vibrations in a crystal as the temperature of the crystal is lowered. The experimental data agrees with the predictions of the equations of quantum mechanics, so the quantum mechanical zero temperature vibrational fluctuations of atoms in matter is real. It is this residual quantum mechanical vibrational energy that keeps liquid helium from freezing even when it is cooled to within microdegrees of absolute zero temperature.

UNCERTAINTY PRINCIPLE

There is a quantum mechanical "reason" for this zero temperature fluctuation energy—the Uncertainty Principle. The Heisenberg Uncertainty Principle of Quantum Mechanics states that it is not possible to precisely measure the position x and the momentum p=mv of a particle at the same time (m is the mass of the particle and v is its velocity). The accuracy of the position measurement Δx and the accuracy of the momentum measurement Δp must obey the relation $\Delta x\Delta p\geq h$. If there were no residual vibrational energy in the atoms in the block of matter to keep the nuclei in motion, then at T=0 K, the nucleus of each atom would be standing still ($\Delta v=0$) and be right in the center of its cloud of electrons ($\Delta x=0$), which would violate the Uncertainty Principle. Needless to say, many scientists (including Einstein) have tried hard to come up with an experiment in which the position and momentum of a particle is measured at the same time to an accuracy better than $\Delta x\Delta p\geq h$. They all failed, and scientists are now pretty sure that the Uncertainty Principle is more than a "principle," it is a "law" of nature.

There is a corollary to the position-momentum uncertainty pair that will be important later. The Uncertainty Principle also states that it is not possible to precisely measure the energy E of a particle in an infinitely short time t. The accuracy of the energy measurement ΔE of a particle and the time interval Δt in which the energy measurement is made, have to obey the relation $\Delta E\Delta t\geq h$.

ELECTROMAGNETIC FLUCTUATIONS OF THE VACUUM

With the above as background, we now get to the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum. A region of empty space surrounded by matter at absolute zero temperature would seemly have no energy in it. Yet, since electromagnetic vibrations (light and radio waves) can pass unhindered through the vacuum, the vacuum contains the potential to support these vibrations. If we treat this region of vacuum in the same manner as we treated the block of matter, we can say that the vacuum can support electromagnetic vibrations of frequency f. The quantum mechanical equations for the electromagnetic vibrations in the region of vacuum are identical in mathematical form to the equations for the mass-spring vibrations of the atoms in the block of matter, so the equation for the average energy <E> of each of the possible electromagnetic vibrations is the same: $\langle E\rangle=[n(T)+1/2]hf$. Only now, n(T) is the number of photons as a function of temperature, and, as before, when T=0 K, n(T)=0. But also, as in the atom case, even when T is at absolute zero, quantum mechanics predicts that each possible electromagnetic vibration in the region of vacuum will have a residual average energy of $\langle E\rangle=hf/2$. This residual energy is an average. It is not that each possible electromagnetic vibration has a "half a photon" but that roughly half the electromagnetic vibrations have one (perhaps more) photons, while the others have no photon.

Now comes the real problem, and the major reason why we need to carry out experiments to verify that the quantum mechanical electromagnetic fluctuations of the vacuum behave as the equations of quantum mechanics predicts. The block of matter has a large, but finite, number of atoms and therefore a finite total quantum mechanical vibrational fluctuation energy. The region of vacuum, however, can support an infinity of electromagnetic vibrations. The region of vacuum cannot support electromagnetic vibrations with wavelengths larger than its largest dimension, but it can certainly support those electromagnetic vibrations with wavelengths smaller than its size, such as infrared, optical, ultraviolet, x-ray, gamma-ray, etc.

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vibrations. There is no known limit to how small an electromagnetic wavelength can be. Each of these infinity of possible electromagnetic vibrations has an average energy of <E>=hf/ 2. So, according to this train of logic, a region of vacuum is not empty, but instead is teeming with an infinity of "half-photons" of electromagnetic energy. The famous physicist Richard Feynman estimated that if the minimum wavelength of electromagnetic vibrations was assumed to be approximately the size of a proton, the "energy density" of the vacuum would be 10^{108} J/cc or equivalently, the vacuum would have a "mass density" of 10^{94} g/cc. This is much greater than typical nuclear densities of 10^{14} g/cc. It is this high predicted energy and mass content of the vacuum that gives rise to the hopes of many that it may be possible to either: extract "free energy" from the vacuum, "push" on the mass of the vacuum, or use the vacuum mass as "reaction mass."

The quantum physicists explain away this "infinity" of energy by saying that since the vacuum pervades everything, it is only the "differences" in the vacuum energy that are produced by the presence of matter that counts. Needless to say, although the quantum physicists have been able to adjust their equations to cancel out this "infinity" and get the right answers, this is not a philosophically satisfactory solution.

CHARGED-PARTICLE PAIR FLUCTUATIONS OF THE VACUUM

Not only does quantum mechanics predict that the vacuum is teeming with electromagnetic energy, the uncertainty principle predicts that the vacuum is also teeming with pairs of charged particles called electron-positron pairs. Since the fluctuation photons in the vacuum have energy, then no matter what their energy is supposed to be, there is a finite probability that for a very short time Δt their energy will be "uncertain" by an amount ΔE that is sufficient to create a positron-electron pair. This event, of course, violates the law of conservation of energy, but quantum mechanics allows the violation to take place provided the positron-electron pair annihilates back into the original low energy photon in a time shorter than the time Δt allowed by the uncertainty relation $\Delta E \Delta t > h$. This means that the supposedly empty vacuum is not only full of photons, but also has a tenuous "plasma" of charged positron-electron pairs. This "plasma" makes the vacuum have an index of refraction slightly different than unity and makes it respond non-linearly to strong electromagnetic fields.

VERIFICATION

It would be simple to say that since this train of logic concerning the effect of quantum mechanics on the vacuum has led to such ridiculously high estimated energy density levels for supposedly empty space, that there is something wrong with the logic, and the vacuum does not have quantum mechanical electromagnetic fluctuations at zero temperature. Yet experiment after experiment has been carried out whose results can be explained by assuming that the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum are real. One such experiment is the Casimir experiment, described in more detail in the main body of the report. In this experiment, two uncharged conducting plates are put near each other with a vacuum between them. Prior to the introduction of the plates, the region of vacuum between the plates had an infinity of possible electromagnetic vibrations and an infinite amount of quantum mechanical electromagnetic fluctuation energy. Since the plates are conducting, they will short-circuit those electromagnetic vibrations that do not have zero electric field at the position of the conducting plates. In effect, this cuts in "half" the "infinity" of electromagnetic vibrations allowed in the region of vacuum between the plates. The vacuum now has less energy than it did before the plates were introduced. This "negative energy" in the region of vacuum produces a force on the plates that pulls the plates together. A similar result is predicted when the plates are made of dielectrics instead of conductors. This attractive force can be quite large and has been accurately measured using dielectric plates. These experiments show that indeed, the vacuum does contain quantum mechanical zero temperature electromagnetic fluctuations. Experiments using conducting plates are more difficult and have yet to be done accurately. Such an experiment is at the top of the priority list in the body of the report.

Another important experiment was the Lamb-Retherford experiment, where the frequency of microwave radiation emitted by an excited hydrogen atom was compared with theory. The theory only agreed with the experiments when the theorists assumed that the vacuum between the proton nucleus and the orbiting electron in the hydrogen atom had a tenuous plasma of positron-electron pairs in it, that shifted the electron orbital energy just the right amount to agree with experiment. Thus, this experiment shows that, indeed, the vacuum does contain quantum mechanical charged-particle pair fluctuations at zero temperature.

There are many other experiments and phenomena that can only be explained by assuming that the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum are real. Even such mundane phenomena as the surface tension of liquids and the clumping of smoke particles are explained by assuming that the vacuum contains residual electromagnetic fluctuations even at zero absolute temperature.

ALTERNATE THEORY

There does exist an alternate theory. In this "Fluctuating Charged Particle Source Field Theory," it is assumed that although the quantum mechanical zero temperature vibrational fluctuations of atoms in matter do exist, the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum do not exist. (The theory does not explain why one type of fluctuation is allowed and the other is not allowed, it just assumes it.) The theory then goes on to say that all the experiments to date, including the Casimir experiment and the Lamb-Retherford experiment can be explained by saying that: (1) The quantum mechanical zero temperature vibrational fluctuations of matter causes the charged particles in the apparatus to undergo random vibrational fluctuations. (2) These fluctuating charged particle "sources" emit electromagnetic radiation fields that travel through the vacuum where they are "received" by all the other charged particles in the apparatus. (3) The electromagnetic radiation field acts on the receiving charged particles to cause them to move "in phase" with the transmitting charged particle "sources." (4) The "in phase" motions of the two widely separated charged particles produce correlated forces between the "source" particle and the "receiving" particle that in turn produce the observed experimental results.

Amazingly enough, this alternate theory where the vacuum is assumed to have no fluctuations, seems to make the same predictions as the quantum theory where the vacuum fluctuations are assumed real. There is an experiment that can possibly distinguish between the two theories. It is described in the report.

SUMMARY

There is a lot more to quantum mechanics than quantization of mass and energy and the Heisenberg uncertainty principle, but I hope this introductory tutorial has been enough to help you understand why it is important to learn more about the quantum mechanical zero temperature electromagnetic fluctuations of the vacuum. Hopefully, the experiments proposed in the body of the report, if successfully carried out, can increase our knowledge and eventual

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applications of this "enigma cloaked in nothingness" called the vacuum.

RANKED LIST OF POSSIBLE EXPERIMENTS

The following is a list of possible experiments ranked in order in terms of: (1) Improving our understanding of the vacuum. (2) The feasibility of carrying out the experiment. (3) Producing a modification in the gravitational or inertial mass of a body. In the pages following are more detailed discussions of the selected experiments.

1. Measurement of Casimir Force on Conducting Plates

The Casimir force on closely spaced conducting plates has never been measured accurately over a wide range of spacings or a wide range of conducting materials. Such experiments need to be done to verify that the force predicted by Casimir (1948) is real and applies to all conducting plates despite their composition. This experiment is ranked first because it is fundamental and relatively easy to carry out with modest funding. It also has the advantage that once a university or contracting team has carried out the first set of experiments, additional experiments with different conductors and different conductor shapes can be carried out on-site at AFPL with duplicate apparatus.

2. Casimir Stress Induced Anisotropic Inertial Mass Measurement

Scharnhorst (1990) used quantum electrodynamics to predict that the speed of light between two conducting plates is anisotropic, with the speed perpendicular to the plates being greater than c. The anisotropic inertial mass experiment assumes that the mass of a body between two conducting plates will also be anisotropic, and proposes to measure that mass anisotropy using a nuclear magnetic resonance technique developed by Drever (1961). This experiment is ranked second despite its great difficulty, because the theory will give a definite prediction of the magnitude of the mass anisotropy expected, so either a positive or negative experimental result will provide a definitive test.

3. Generating "Subcosmic Rays" in a Cold Vacuum Chamber

Rueda, Haisch, and Cole (1995) predict that the electromagnetic fluctuations in the vacuum will accelerate isolated charged particles to high speeds. The theory predicts energy gains of a proton of the order of 1000 eV per second. This should be easily measured by "releasing" a "cooled" antiproton in a cryogenically cooled electromagnetic trap and measuring how fast it reaches the walls and annihilates. This experiment is ranked third, despite its complexity and cost, because a positive result would "prove" that you can continuously extract unlimited amounts of "free energy" from the vacuum. We know, of course, that nature is not going to let us violate the law of energy conservation, but finding out how nature enforces the energy conservation law will teach us new physics.

4. "Inertia Wind" Experiment

Puthoff, in unpublished work that extrapolates from the paper by Haisch, Rueda, and Puthoff (1994), predicts that a pair of 40 kg masses rotating in a 1 m radius circle at 20 rpm will create an "inertia wind" that will "push" on a sensing mass. He originally predicted the magnitude of the "inertia wind" force would be comparable to the magnitude of the Newtonian force produced by the 40 kg masses. His coauthors are skeptical of the predicted magnitude, and Puthoff is reworking the calculations to obtain a more definitive prediction. This experiment, despite its simplicity and direct relevance, is ranked fourth because, while a positive result will "prove" the theory, a null result will prove nothing. There are also grave doubts that a large effect of this type would have gone unobserved before now.

In addition to the ranked experiments, there are two additional experiments that are described in the main body of the report, but which are not recommended for consideration because the Principal Investigator was not able to identify an experimental approach that would be able to carry out the desired measurement at the signal-to-noise levels required. Perhaps someone reading this report can devise an experimental approach that will make a measurement feasible.

Nonlinearity of Vacuum Experiments

Ding and Kaplan (1989) proposed to generate second-harmonic photons by focusing laser light on a vacuum containing a magnetic field. This is the only experiment known that can distinguish between the two alternate models for vacuum fluctuation effects, the model where the vacuum itself has electromagnetic fluctuations, and the model where the charged particles in the experimental apparatus are doing the fluctuating. Unfortunately, recent estimates by Kaplan and Ding (1995) on the laser power and magnetic field strengths needed have resulted in numbers that are beyond the capabilities of present lasers and magnets.

Making and Weighing "Casimatter"

Schwartz has recently proposed over the Internet that it might be possible to physically "weigh" the Casimir energy in a sample of "Casimatter" composed of thousands of layers of 80 nm thick aluminum alternating with 50 nm thick magnesium fluoride (MgF_2). The Casimir energy generated between the conducting aluminum plates would make a finite (negative) contribution to the energy and thereby the mass of the Casimatter sample. He proposes weighing the sample of Casimatter, heating the Casimatter to destroy the layer separation, thus eliminating the Casimir energy contribution, then weighing it again. The mass measurement accuracy required is estimated to be greater than a part in 10^{17}. The force sensitivity levels are beyond the present capabilities of available atomic force microscopes and the accuracy required for a frequency measurement is beyond the capabilities of available clocks.

MEASUREMENT OF CASIMIR FORCE ON CONDUCTING PLATES

In a difficult to find, but widely quoted paper entitled, "On the attraction between two perfectly conducting plates," Casimir (1948) predicted that the quantum fluctuations of the vacuum should produce a pressure P or force F per unit area A on two perfectly conducting uncharged plates given by:

$$P = \frac{F}{A} = \frac{\pi h c}{480\, L^4} \qquad (1)$$

where $h=6.63\times10^{-34}$ J•s is Planck's constant, c=300 Mm/s is the speed of light, and L is the separation distance between plates. The appearance of Planck's constant indicates that the effect is due to a quantum mechanical phenomenon. The amazing aspect of the equation is that the predicted force is independent of the material of the plates, as long as they can be considered "perfectly conducting." This means that the equation should be good down to separation distances L that are comparable to the cutoff wavelength of the material.

Everyone assumes that the Casimir force between two conducting plates has been "experimentally demonstrated." It has not. Nearly all the published "Casimir force" experiments used dielectric plates such as glass, quartz, or mica instead, with the most accurate data obtained using cylindrically curved mica surfaces [Israelachvili and Tabor (1972)].

Barton points out that these experiments on dielectrics are not tests of the Casimir force, but instead are tests on the allied but significantly different Van der Waals

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forces. The Van der Waals force between two dielectric plates is predicted by an equation in the paper by Lifshitz (1956):

$$\frac{F}{A} = \frac{\pi hc}{480 L^4}\left(\frac{\epsilon - 1}{\epsilon + 1}\right)^2 \phi(\epsilon) \quad (2)$$

where ε is the dielectric constant of the plates, and $\phi(\varepsilon)$ is a function that varies from 0.35 when ε=1 to 1.0 when $\varepsilon \rightarrow \infty$. It is true the Lifshitz equation turns into the Casimir equation when the dielectric constant is allowed to go to infinity, but anything involving an infinity is suspect.

The last experiments on highly conducting metal plates were carried out by Sparnaay (1958). His measurements on two chromium or two chromium-steel plates did "not seriously deviate from Casimir's predictions, although the attractions found are somewhat too large. No attractions could be measured between two aluminum plates." The data in the Sparnaay paper is of poor quality. Not only was the magnitude of the Casimir coefficient poorly determined, but because of the experimental difficulties the $1/L^4$ behavior with separation distance L was not firmly established, and there was no attempt to show a failure of the Casimir force law at small plate separations when L is smaller than the cutoff wavelength of the conductor.

The most recent experiments using "conducting" plates were published by Arnold, et al. (1979). These experiments used semiconducting silicon plates rather than highly conducting metal plates. Arnold found a change when the silicon was illuminated to make it more conducting, but the experimental results did not agree well with the Casimir theory.

Sen (1995) at the University of Washington is presently attempting to measure the Casimir force between two gold-plated quartz flats 5 cm in diameter. The experiment is an undergraduate honors project, which will impact on the time and money available to make thorough measurements. There will also be no attempt to make measurements at close plate separations. Serry, et al. (1995) at the University of Illinois at Chicago are planning Casimir force experiments using aluminum plates embedded in and supported by a silicon-fabrication-based microelectromechanical structure. The minimum separation distances obtainable using this fabrication technique should be better than L=20 nm. The Casimir forces on the supported aluminum plates can be measured using a modification of a commercially available atomic force microscope. The first goal of the UIC group is to build an "Anharmonic Casimir Oscillator" that will oscillate about an equilibrium between the Casimir force and the force of a spring. Such structures could be used to make precise measurements of the Casimir force at different separation distances L and for different conductors. Onofrio and Carugno (1995) in Italy are also planning a Casimir force experiment between conducting plates using a tunneling electromechanical transducer.

It is recommended that the first priority in proposed experiments to study the properties of the vacuum is an experiment to measure the Casimir force between two conducting plates. The experiment should be carried out with a number of different metals over a wide range of plate separations with an accuracy that can determine not only the coefficient in the Casimir equation, but the $1/L^4$ variation in the force.

The experiments should also be designed to show that the Casimir coefficient and the $1/L^4$ law are independent of the type of conductor used—down to the point where the separation distance becomes comparable to the cutoff wavelength of the metal. That minimal separation distance, in turn, should be a predictable function of the cutoff wavelength of the conductor being used.

The experiments should investigate other structures than parallel plates, since the Casimir force between conductors is not always attractive. A hollow conducting sphere experiences an outward repulsive force [the most accurate recent calculation is by Milton (1978)]. Ambjørn and Wolfram (1983) have derived the Casimir energy per unit volume for conducting rectangular boxes. Cubes have positive energy and repulsive forces on the walls, long rectangles or parallel plates have negative energy and attractive forces on the walls, while a rectangular box of relative dimensions 1 by 1 by 3.3 has zero Casimir force. It would be desirable to verify these predictions.

CASIMIR STRESS INDUCED ANISOTROPIC INERTIAL MASS MEASURMENT

The Casimir stresses on the vacuum space between two conducting plates are anisotropic. Scharnhorst (1990) and Barton (1990) [see also Barton and Scharnhorst (1993)] used this stress anisotropy to predict an anisotropy in the velocity of light. According to their theoretical calculations, the velocity of light parallel to the conducting plates has the speed of light in an unbounded vacuum, $c_l=c_o$, while the velocity of light perpendicular to the plates has a speed greater than c by the amount:

$$c_\perp/c_0 = 1 + \frac{11\,\pi^2}{8100}\,\frac{\alpha^2}{(L/L_e)^4} \quad (3)$$

where L is the spacing between the Casimir plates, the fine structure constant α=1/137, and $L_e=h/2\pi m_e c=3.86\times10^{-13}$ m/rad= 0.386 πm/rad is the reduced Compton wavelength of the electron. Numerically, this amounts to a difference of:

$$c_\perp/c_0 = 1 + 1.59\times10^{-56}\left(\frac{meters}{L}\right)^4 \quad (4)$$

which implies that the speed of light perpendicular to the conducting places is greater than c.

Some important features of this result are [Barton (1990)]:

(1) This anisotropy of the vacuum space between Casimir plates is calculated to be greater than any dispersion effect, so the phase and group velocities of the light are both given by the same equation and both are greater than c, causing concerns about violation of causality. Fortunately for the sensibilities of those worried about this, Milonni and Svozil (1990) show that Heisenberg uncertainty principle will probably work to prevent the use of faster-than-c propagation for the reliable transmission of information back in time.

(2) The size of the effect is the same everywhere between the plates except perhaps very near to the surface of the plates where some of the approximations used might not be valid. By very close, Scharnhorst (1990) states "near denotes a distance of a few Compton wavelengths apart from the plates." An electron Compton wavelength is $2\pi L_e$=2.43pm, much smaller than proposed Casimir plate separation distances, typically measured in nm.

ESTIMATE OF ANISOTROPY MAGNITUDE

It is possible (although difficult) to use ion beam lithography and other sub-micron microelectronic fabrication and processing techniques to construct microelectromechanical structures, such as Casimir volumes, electromagnetic antennas and guides, and atomic force microscopes, with dimensions, spacings, and control of motion accurate to distances of 1 nm (10 Å) or less. Our real limit to the spacing distance L, however, is not our ability to fabricate the required Casimir structures. The theory behind equation (3) assumes that the Casimir plates are conducting at all frequencies of the electromagnetic spectrum. Real metals become transparent in the ultraviolet. The broadest band reflector is

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aluminum, which has a reflectance of 99% in the long infrared, a reflectance of 90% at a wavelength of 120 nm, and becomes transparent at 10 nm [AIP Handbook (1972), see Table 6g-1, pp **6**-124ff and Table 6g-2, pp **6**-157]. Little data exists between the available 120 nm and the 10 no data points, but I would estimate that the minimum wavelength at which the Casimir plates can be considered conducting is about λ=60 nm/cycle, or a reduced wavelength of about $\lambda/2\pi$=10 nm/rad.

If the theorists agree that equation (3) can be applied to aluminum Casimir plates at a separation distance of L=10 nm, then the maximum magnitude of the Scharnhorst effect achievable in a fabricatable piece of apparatus becomes:

$$c_{\perp}/c_{||} = 1 + 1.59\times10^{-24} \quad (5)$$

The question now is: Is it possible to measure such a small anisotropy?

MEASUREMENT OF THE SCHARNHORST EFFECT ON LIGHT SPEED

I have been unable to conceive of a method for measuring an anisotropy in the speed of light between two conducting Casimir plates at the level of parts in 10^{-24}. One could think of converting the velocity measurement into a frequency measurement by finding the resonant frequency of a tuned cavity for different Casimir plate spacings, but there are many things other than the Scharnhorst effect that will cause the resonant frequency of a cavity to change.

In addition to the experimental difficulties of making a speed of light measurement, there are theoretical problems that must be addressed first. There have been papers published [Milonni and Svozil (1990) being just one example] which show that the Heisenberg uncertainty principle will produce timing uncertainties in the atoms used to generate and detect the light photons used in the speed measurement. These timing uncertainties will prevent the accurate measurement of the speed of light or the sending of information faster than c.

EFFECT OF CASIMIR STRESSES ON INERTIAL MASS

As Landis pointed out in the NASA/JPL Workshop on Advanced Quantum /Relativity Theory Propulsion [Bennett, et al. (1995)], if the velocity of light is anisotropic between Casimir plates, then since $m=E/c^2$, perhaps the mass of an object will be anisotropic too. If this is true, it might be easier to measure the anisotropy of inertial mass between Casimir plates than the anisotropy of the velocity of light.

We are not sure that the Casimir stresses will affect the inertial mass of an object. The theory behind the Scharnhorst effect is a perturbation analysis of the inherent nonlinearities in the postulated quantum fluctuations of the electromagnetic fields in the vacuum. Using a simplified model: The fluctuation photons in the vacuum, no matter what their energy, have a finite probability of producing a virtual electron-positron pair with a rest mass energy of 2 x 511 keV, as long as the pair recombines back into the original photon in a time Δt shorter than that allowed by the Heisenberg uncertainty principle for the energy difference ΔE. In this model, the vacuum has a weak virtual "plasma" of charged particle pairs in it, which makes the vacuum polarizable, and gives the vacuum an index of refraction that is not unity. Scharnhorst's actual calculation was not of the speed of light, but of the index of refraction of the vacuum between Casimir plates. He found that the index of refraction was anisotropic, with the index equal to unity in the directions parallel to the plates and slightly less than unity [see equation (24) of Scharnhorst (1990)] perpendicular to the plates. Scharnhorst then converted this anisotropy in the index of refraction into an anisotropy in the speed of light [see equation (25) of Scharnhorst (1990)]. Since an index of refraction less than unity means a speed of light greater than c, this result gave the Scharnhorst effect its world-wide notoriety.

The important message is that the Scharnhorst calculations showed only that the electromagnetic index of refraction between two conducting Casimir plates is anisotropic. I think everyone agrees that the calculation of the anisotropy in the index of refraction is correct. I also think everyone agrees that an anisotropy in the index of refraction will result in an anisotropy in the speed of light. It is not obvious, however, that an anisotropy in the index of refraction for electromagnetic radiation for the vacuum between two conducting plates will produce an anisotropy in the inertial mass of a body. This needs to be verified by a competent theoretician.

ESTIMATE OF THE SCHARNHORST EFFECT ON INERTIAL MASS

I will now assume that the theorists ultimately conclude that, indeed, two conducting Casimir plates will not only produce an anisotropic index of refraction between the plates, and an anisotropic speed of light for photons traveling between the plates, but also an anisotropy in the inertial mass of a body placed between the plates.

The magnitude of the inertial mass anisotropy difference can be estimated by assuming that the total relativistic energy E in the famous equation $E=mc^2$ is a constant that is not affected by the Casimir stress. Substituting the two values for the velocity of light from equation (3) and solving for the mass results in:

$$m_{||} = E/c_{||}^2 = E/c_0^2 = m_0 \quad (6)$$

and

$$m_{\perp} = \frac{E}{c_{\perp}^2} \approx \left[1 - 2\,\frac{11\pi^2}{8100}\,\frac{\alpha^2}{(L/L_e)^4}\right] m_0 \quad (7)$$

Here, m_0 is the scalar inertial mass (assumed to be equal to the scalar rest mass) of the body in an unconstrained vacuum where there are no Casimir stresses, and $m_{\perp}$ and $m_{||}$ are the perpendicular and parallel components of the inertial mass tensor postulated to exist when the body is subjected to Casimir stresses produced by the electromagnetic field constraints resulting from the presence of the two conducting plates.

The assumption that the total relativistic energy of the body, E, is not affected by the presence of the Casimir plates needs to be checked by a competent theoretician. Even if E is also affected by the Casimir stress, it could still turn out that the resultant inertial mass is still an anisotropic tensor, but perhaps by a different factor than that in equation (7).

Under the assumption that equation (7) is valid, and that the calculated Casimir stresses apply for plate separation distances as small as L=10 nm, the predicted numerical value for the maximum anisotropy that can be expected in the inertial mass of a body between two conducting Casimir plates is:

$$m_{\perp} / m_{||} = 1 - 3.17\times10^{-24} \quad (8)$$

This is a small difference, but 35 years ago, using relatively crude equipment, Drever (1961) measured the anisotropy of the inertial mass of the nucleus of a lithium-7 atom and found the anisotropy to be zero at a sensitivity level of 5×10^{-23}. If the Drever technique, or something similar to it, could be applied to a sample confined between two conducting Casimir plates, and the sensitivity of the detecting apparatus could be improved by a few orders of magnitude, then it should be possible to measure the anisotropy of inertial mass caused by two conducting plates at the

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level predicted by the well-accepted theory of quantum electrodynamics. The experiment would thus conclusively demonstrate, one way or the other, whether anisotropic Casimir stresses between two conducting plates can produce a change in the inertial mass of a body.

HUGHES-DREVER ANISOTROPIC INERTIAL MASS NULL EXPERIMENT

The motivation for the Drever experiment [first carried out by Hughes in 1960 at a lower sensitivity] was an experimental test of Mach's principle—that the inertial mass of a body may arise from a gravitational coupling with distant matter. Since there is a concentration of matter at the center of our Galaxy, then, depending upon what physical and mathematical models one used for Mach's principle, this excess of nearby matter might result in an anisotropy of inertia along the (bi-)direction to the mass excess, which could be detected experimentally as the Earth rotated the apparatus with respect to the Galactic center.

According to some theories referred to by Drever (1961), this anisotropy in inertial mass should cause shifts in the energy levels of atoms and nuclei subjected to a magnetic field. Specifically, in a nucleus with spin I=3/2, the energies of the states with magnetic quantum numbers m= ±3/2 would be increased slightly if the magnetic field were parallel to the direction of the center of the Galaxy, while the energies of the states with $m_I=\pm 1/2$ would be decreased by an equal amount. If the magnetic field were perpendicular to the direction to the center of the Galaxy, the energies would be shifted in the opposite directions. For the models of inertia being proposed at the time, the predicted ratio of the anisotropy in inertial mass for the nucleus was in the order of 10^{-13}. Drever found it was zero to a sensitivity of 5×10^{-23}.

The isotope used was lithium-7, with a nucleus of spin I=3/2, caused by an unpaired $P_{3/2}$ proton. The four energy levels of a nucleus of spin 3/2 in a magnetic field are normally equally spaced. The three resonant frequencies between the four states are the same and there is a single resonance. If the $m_I=\pm 3/2$ energy levels are shifted with respect to the mI=±1/2 levels, then the single resonance is split into a triplet. The minimum splitting detectable is usually limited by inhomogeneities in the magnetic field, so a weak uniform field is desirable. The magnetic field used in the experiment was the earth's field.

In the experiment, the lithium-7 sample, in the form of a solution of lithium nitrate, was contained in a plastic bottle surrounded by a coil placed with its axis perpendicular to the direction of the earth's field. A direct current through the loop produced a field of about 200 gauss. When this field was switched off rapidly, the resultant nuclear magnetic moment precessed about the earth's field and an alternating e.m.f. signal was generated in the coil. With no anisotropy to cause shifts in the energy levels, there would be a single resonant frequency present and the signal would decay exponentially with a time constant equal to the transverse relaxation time of the spin system. If, however, an anisotropy in inertial mass exists, the resonance response would be split into a close triplet, and the signal would exhibit beats, corresponding to interference between the oscillations at the three resonance frequencies. Very long beat periods would show up as changes in the decay curve shape and 1/e time as the experimental parameters that changed the anisotropy were varied. In Drever's null experiment, the rotation of the earth changed the direction with respect to the Galactic center once a sidereal day. No variation was found. This corresponds to [Drever (1961)]: "an upper limit for the ratio of the anisotropic part of the inertial mass of a proton to the isotropic part of the order of 5×10^{-23}."

It should be noted at this point that the lithium-7 nuclei being measured were in a non-symmetric chemical compound, were surrounded by non-symmetric polar water molecules, and a large fraction of them were up against container walls, yet these nonsymmetric surroundings did not induce shifts in the magnetic energy levels that would mimic a differential shift in the energy levels caused by an anisotropic inertial mass of the nucleus.

The fundamental beauty of the Drever experiment is that the nucleus is "self-referencing" in that the $m_I=\pm 3/2$ and ±1/2 nuclear magnetic states produce identical transition frequencies despite large and non-symmetric changes in the surrounding environment that can produce large changes in the absolute energies of the magnetic states, but do not produce differential shifts between the 3/2 and 1/2 states. This probably occurs largely because the nucleus is small in size compared to the distances to neighboring perturbing atoms. It is only when the nucleus itself changes, by developing an anisotropy in inertial mass, that the transition frequencies change with respect to each other and produce the beat notes. The beat notes are the signal that something has happened.

CAVEATS CONCERNING OTHER EFFECTS MASKING SCHARNHORST EFFECT

Barton and Scharnhorst point out that there are other effects that may produce a mass anisotropy that may mask the mass anisotropy produced by the Scharnhorst effect. These effects are of first order in α, and therefore much larger. How precisely they might influence any specific measurement would need to be thought through. There are papers available that discuss these effects, such as G. Barton, "Quantum mechanics of charged particles near a plasma surface," *J. Phys.* A10, 601 (1977), and for particles between two mirrors in G. Barton, *Proc. Roy. Soc.* (London) A320, 251 (1970), and an update with applications to a neutral atom in *Proc. Roy. Soc.* (London) A410, 141 (1987). All of these need to be investigated by a competent theorist before much time is spent on designing experiments.

I suspect, however, that these papers will either produce an "effective mass" or an "effective mass anisotropy" that comes about due to the interaction of the charges in the atoms under consideration with the charges in the plasma or mirrors. These are not fundamental changes in the inertial rest mass of the atom, just an "effective mass" induced by the coupling of the atom to its surroundings. I would suspect that these nonsymmetric effects, just like the non-symmetric effects in the original Drever experiment, will not cause a change in the magnetic level spacing. This, however, needs to be proven.

APPLYING FREE PRECESSION TO A CASIMIR ANISOTROPY EXPERIMENT

The Drever measurement was made by using a nuclear magnetic free precession technique on a bottle of water containing lithium nitrate, which gave better relaxation times than other compounds. The frequency of precession in the earth's magnetic field was 800 Hz and the decay time of the signal was 3.7 s. In practice, the signal was weak and it was necessary to use 2.5 liters of sample to obtain an adequate signal-to-noise ratio. It is obvious that much thought and work needs to be done to convert this experiment into one that can be done within the confines of two closely spaced conducting plates.

Extracting the Signal

The free precession signal in the Drever experiment was a radio-frequency signal of about 800 Hz. The radio frequency is proportional to the applied magnetic field. It might be thought that the nearby presence of the conducting Casimir plates would prevent extraction of the signal. It should be possible, however, to design the radio-frequency portions of the detection circuit so that the conducting Casimir plates are part of the circuit. For example, the Casimir plates could also be the capacitor plates of an RLC circuit resonant at the desired radio frequency. Alternatively, the plates could be designed with spiral conductive pattern, so they could simultaneously be a "pickup coil" at the desired radio frequency signal band and a "mirror" at optical wavelengths. In another approach, the applied magnetic field could be increased until the signal frequency is in the microwave band. The Casimir plates could then be designed as a "waveguide" with a very small height-towidth ratio, operating in the transverseelectric (TE) mode, to extract the signals in the desired microwave band in the direction parallel to the conducting plates, while acting as a mirror at optical frequencies in the direction perpendicular to the plates.

Drive signals can be inserted into the sample either by modifying the structure of the conducting plates as mentioned before, or by simply driving the conducting plates hard with a high power signal and having a small portion of the drive power leak through the conducting plates into the sample inside by evanescent wave propagation.

Sample Size

Drever used a 2.5 liter=2.5×10^{3} cc sample in order to get sufficient signal. The volume in between two 5 cm by 5 cm Casimir plates separated by 10 nm is 2.5×10^{-5} cc, or a factor of 10^{8} reduction in sample size and expected signal, even if we used the entire volume, since the Scharnhorst effect is constant everywhere in the region between the plates. Unless some other complication arises, I would propose filling the volume between the Casimir plates entirely with sample in the form of a high resistivity, low loss dielectric (either liquid or solid). A solid dielectric containing the desired I=3/2 spin nuclei would be especially easy to work with. Starting with a flat substrate, the deposition of a layer of aluminum, a layer of the dielectric with the desired thickness, and another layer of aluminum (perhaps with some structure to allow electromagnetic coupling to the sample), would result in an encapsulated sample ready to test.

The sample volume and output signal can be increased by designing the radio frequency portion of the structure as a long, possibly folded, waveguide, or as a series or folded parallel multiplate capacitor, with the capacitor plates acting also as the conducting Casimir plates.

Effect of Sample on Casimir Stress

The theorists who calculate the expected mass anisotropy effect should be asked to look at the case where the space between the conducting plates is not a vacuum at zero temperature, but a dielectric with a finite index of refraction, a finite (but very high) resistivity, and a finite temperature. Barton (1990) has already done this for the vacuum between conducting plates at a finite temperature. I expect the results of the theoretical calculations will be that the anisotropic Casimir stress remains, although the magnitude may be changed slightly. One expected side effect of filling the cavity with a dielectric sample medium is that although the speed of light will still be anisotropic, the speed of light perpendicular to the plates will no longer be greater than c.

Measurement Sensitivity

The sensitivity of electronic amplifiers has improved substantially in the past 35 years. It is not known whether that improvement has been enough to not only compensate for the decreased sample size, but to also provide additional margin to close the gap between the 5×10^{-23} sensitivity of the Drever measurement and the 3.17×10^{-24} sensitivity needed to measure the Casimir stress induced inertial mass anisotropy as given by equation (8). To improve the signal-to-noise ratio, experts in NMR need to be consulted as to the best nucleus to use, the best compound to put it in, the best host lattice or solution, the optimum magnetic field strength to be applied, the best radio frequency circuit/amplifier combination to extract the response sig-

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nal, and the best NMR technique to be used (driven resonance or free precession).

SUMMARY

Theorists using the well-accepted theory of Quantum Electrodynamics to calculate the effects of the quantum fluctuations in the vacuum, predict that the velocity of light can be changed by Casimir stresses induced in the vacuum by the presence of a pair of closely-spaced conducting plates. It is not yet known, but it is suspected, that the same Casimir stresses will cause a change in the inertial mass of an object. The effect is minute, but it may be possible to design an experiment using a nuclear magnetic resonance free precession technique to measure that change in the inertial mass. The result of the experiment will either be that the inertial mass of a body can be changed, or that our theories of the vacuum must be changed. The implications for either experimental result will be significant.

GENERATING "SUBCOSMIC RAYS" IN A COLD VACUUM CHAMBER

Calculations by Rueda (1978), Cole (1995) and Rueda, Haisch and Cole (1995), indicate that in a very empty region of space with few particles and weak magnetic fields, the vacuum fluctuations will randomly push charged particles to higher and higher speeds until they approach the speed of light. This might be the cause for cosmic rays. According to Haisch, there is a quite large effect on protons, of the order of 1000 eV increase in energy per second. This level of energy is much greater than the thermal energy of a gas of 3/2 kT (0.04 eV at T=300 K), and larger than any stray "patch" voltages that may exist in a piece of experimental apparatus.

It might be possible to set up a very empty, very cold vacuum chamber, with a single charged particle in it, and monitor the velocity of the charged particle with time to see if it is accelerated. Haisch has suggested that instead of a proton, that an antiproton be used. This suggestion has many advantages over attempting to use any other particle. Since the theory gives a definitive prediction for a proton, the result should be the same for an antiproton. A single antiproton can been trapped, cooled to millikelvin temperatures, and its presence and initial position in the trap confirmed before the trap voltages are turned off. A sealed cryogenically cooled trap has essentially no residual air molecules in it. This has been proven by keeping 100,000 antiprotons in a trap for over a month without losing any since an annihilation of an antiproton by a nucleus would have produced easily detectable gamma rays or high energy pions. The traps can be made with a large working area along the axial direction. The antiproton can be "dropped" from essentially zero starting velocity and let fall a number of centimeters. Longer "drop" times can be obtained using a drop tower.

When the antiproton finally strikes the wall of the trap, it will annihilate with the wall nuclei. The annihilation produces 2-6 gamma rays and 3-7 high energy pions, all of which are easily detected by a surrounding complex of radiation detectors. The pion tracks and the gamma ray events can be triangulated back to determine the annihilation point to a mm or so, so the exact time and place of the annihilation event can be determined.

The experiment would then be repeated a number of times until a pattern of annihilation events is obtained. If the pattern is concentrated at the trap bottom, then only gravity accelerations are involved. If the pattern is concentrated at a few spots on the trap walls, then there are "work function patches" on the walls that are attracting the antiprotons to the patches by their electrical potential. If however, the pattern is random in space and very short in time, then this is good evidence that the vacuum electromagnetic fluctuations are the acceleration mechanism. One important aspect of this experiment, is that if the acceleration mechanism is found to operate, then this demonstrates at least one mechanism for the continuous extraction of limitless amounts of "free energy" from the vacuum.

"INERTIA WIND" EXPERIMENT

According to unpublished studies by Puthoff, accelerating and decelerating inertial masses interact with the surrounding vacuum fluctuation field and create an "inertia wind" that propagates out through the vacuum. If a test mass is placed near the source, the outspreading inertia wind will interact with the test mass, pushing or pulling it, and causing it to respond. Puthoff originally calculated that a pair of 40 kg source masses rotating in a 1 meter radius circle at about 20 rpm can create an attractive or repulsive inertia wind force on a test mass comparable in amplitude to the attractive Newtonian gravitation force of the source masses. Puthoff has built some apparatus and is presently conducting experiments. The output of his sensing apparatus is presently dominated by large noise signals, such as ground noise and magnetic coupling to the rotating steel beam holding the generating masses.

There is yet no publication which describes the experimental apparatus and which outlines in mathematical detail the physical model used to predict the experimental result. Such information that exists can be obtained by contacting Puthoff directly.

Although Puthoff feels that the "inertia wind" theoretical model he is using to design the experiment and predict the experimental results is a straightforward extrapolation of the theory in the paper by Haisch, Rueda, and Puthoff (1994), his coauthors on the original paper are skeptical of the predicted magnitude, and Puthoff is now reworking the calculations to obtain a more definitive prediction. Rueda, in particular, feels that any "wave" generated by an accelerating mass would stay attached to the mass as a "solitonic type" wave, and would not create an "inertia wind" to detect.

The reason this experiment is placed low on the priority list is that Puthoff's colleagues on his theoretical paper do not agree with Puthoff's inertia wind theoretical extension of their joint paper. Thus, this experiment fails the criteria that a null result will disprove the theory.

It would seem to me, that a force this large would have been noticed before, especially during gravity antenna calibration experiments carried out by Forward and Miller [*J. App. Phys.* 38, 512-518 (1967)] using rotating masses and Sinsky [Ph.D. Thesis, University of Maryland (1967)] using vibrating masses. These experiments should be reanalyzed using the Puthoff "inertia wind" model to see if the "inertia wind" effect should have been seen in those papers. Puthoff and Little are presently analyzing the Forward paper.

Also, according to Puthoff, rapidly rotating gyroscopes should produce an inertia wind. This should lead to measurable forces and torques of one gyroscope on another. It would seem that these forces would have easily been seen by now, especially if torques are generated, since the gyroscopes on precision inertial platforms are fairly close to each other. Again, calculations need to be done.

NONLINEARITY OF VACUUM EXPERIMENTS

In the paper, "Nonlinear Magneto-Optics of Vacuum: Second-Harmonic Genera-tion," Ding and Kaplan (1989) proposed to generate second-harmonic "doubled" photons by focusing intense pulsed laser light on a region of the vacuum that had a strong magnetic field in it. According to classical electromagnetic theory, the electromagnetic field is completely linear, so there should be no interaction between the laser photons and the magnetic field. But if the fluctuations of the vacuum are taken into account, then the virtual positron-electron particle pairs created by the fluctuations result in a polarizable "plasma" in the region that can provide the nonlinear coupling mechanism needed to generate the second-harmonic photons.

This experiment is important since it can distinguish between two existing physical models for the vacuum. In the standard quantum mechanical model, not only do atoms in matter undergo residual vibrational fluctuations even at zero absolute temperature, but the vacuum itself contains residual electromagnetic fluctuations. In the alternative "Fluctuating Charged Particle Source Field Theory" model, it is assumed that although atoms undergo residual vibrational fluctuations, there are no electromagnetic fluctuations of the vacuum and especially, there are no charged-particle positron-electron pairs being created in the vacuum. All the effects that occur in this model are produced by the vibrational fluctuations of the charged particle "sources" in the apparatus creating electromagnetic fields that pass through the vacuum to the other charged particles in the apparatus, causing them to vibrate in phase with the "source" particles. This "in--phase" sympathetic vibration produces forces which produce the experimental results.

The interaction region in the proposed experiment by Ding and Kaplan will contain only laser light, magnetic fields, and vacuum. It will contain no charges, no polarizable particles, and no conductors, so there is no mechanism to explain a successful experimental result from the fluctuating chargedparticle source field point of view—unless one cannot ignore the currents in the source of the magnetic field, even though that source is distant from the interaction region. A positive result from the experiment of the right magnitude would "prove" that the vacuum itself contains quantum fluctuations of the electromagnetic field. A null result from the experiment would "prove" that the fluctuation charged-particle source field model is the more "correct" model, and the idea that the vacuum itself has fluctuations is not a correct physical picture.

This experiment would be difficult to do, since it requires high laser intensities and high magnetic fields at the same time. The field intensities required to produce a detectable number of doubled photons were recently re-estimated by Kaplan and Ding (1995) to be 10^{22} W/cm^2 of pulsed laser flux focused on a 1000 T pulsed magnetic field. These required laser intensities are far beyond those projected to be available in the near future, so this experiment is not recommended for consideration at the present time.

There is an alternate way to do the experiment. Instead of concentrating a large number of laser photons of moderate photon energy into a small region to obtain the required high photon energy density, the energy of the individual photons can be increased so as to obtain the required high energy density with fewer photons. An Italian group [Bakalov, et al. 1994) has proposed an experiment using a 9 T magnetic field and high energy photons produced by a particle accelerator rather than a laser. A successful measurement would amount to a direct observation of the "polarization" of the vacuum produced by the production of charged-particle positron-electron pairs in the vacuum. This experiment is being funded as part of the Italian high energy physics program.

MAKING AND WEIGHING CASIMATTER

Alan M. Schwartz has recently proposed over the Internet that it might be possible to physically "weigh" the Casimir energy in a multigram sample of "Casimatter," composed of thousands of layers of 80 nm thick aluminum alternating with 50 nm thick magnesium fluoride (MgF_2), which is a good dielectric that is easy to deposit. The Casimir energy generated between the conducting aluminum plates would make a finite (negative) contribution to the energy and thereby the mass of the Casimatter sample. He proposes weighing the sample of Casimatter, heating the Casimatter to destroy the layer separation, thus eliminating the Casimir energy contribution and turning the Casimatter into ordinary matter, then weighing it again. His internet message did not go into great detail and did not give an estimate of the size of the effect to be expected. It is, however, relatively easy to take his idea, push it to the extreme, and see if the maximum calculated mass difference is within the reach of possible future measurement techniques, and thus is a possible candidate for a mass modification experiment.

Aluminum has a reflectance of 90% at a wavelength

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of λ=120 nm/cycle [*AIP Handbook*, 3rd Ed. (1972), Table 6g-1, page **6**-124] and drops after that, but there is no handbook information what the cutoff wavelength is. (Elsewhere in this report, on page 15, I estimate it at λ=60 nm/cycle.) The minimum thickness of aluminum film needed to give that high 90% reflectance is about 40 nm [*AIP Handbook*, 3rd Ed. (1972), Table 6g-4, p. **6**-159], although the reflectance of a thin aluminum film is still 87% at 30 nm thickness and 76% at 20 nm thickness, so thinner films can be considered if desired.

I will assume (as I did on page 15), that the appropriate Casimir plate spacing L for a given cutoff wavelength is not the wavelength (L=λ), or half the wavelength (L=λ/2), but instead the reduced wavelength given by L=$\lambda/2\pi$. [This assumption needs to be verified by a competent theorist, and if not correct, then the following analysis needs to be revised with new numbers.]

Given the above, let us consider an extreme version of Casimatter, consisting solely of a very large number of very thin aluminum film layers at very close spacings. I will make the conservative assumption that the reflectance cutoff wavelength for aluminum is λ=120 nm/cycle (90% reflecting), which means that we can consider a spacing between the aluminum plates in the Casimatter of L=$\lambda/2\pi \approx$20 nm, and the thickness of the aluminum films as 40 nm. To simplify things, I will assume that the 20 nm spacing between the aluminum films will be filled with an ideal dielectric with index of refraction 1 and density 1 g/cc.

The Casimir formula for the energy per unit area between conducting plates of area A and spacing L is:

$$u = \frac{U}{A} = -\frac{\pi h c}{1440\, L^3} \quad (9)$$

where h=6.63x10^{-34} J•s and c=300 Mm/s. From this, it is easy to calculate the energy density e in the volume between two of the plate pairs of area A and separation L that make up one of the layers.

$$e = \frac{u}{L} = \frac{U}{LA} = -\frac{\pi h c}{1440\, L^4} \quad (10)$$

For a spacing of L=20 nm, the (negative) energy density is -2.7 kJ/ m^3 or -2.7 mJ/cc. This energy density gives the vacuum a relativistic mass density ρ_V of:

$$\rho_v = \frac{e}{c^2} = -\frac{\pi h}{1440\, c L^4} \quad (11)$$

which for a layer spacing of L=20 nm results in a negative mass density for the vacuum of -3.0x10^{-14} kg/m^3 or -3.0x10^{-17} g/cc.

If we assume the thickness of the aluminum plates to be T=40 nm and the separation between the plates to be L=20 nm, then 2/3rds of the volume will be aluminum with density 2.7 g/cc and 1/3rd will be the ideal dielectric with density 1 g/cc, for an average density of the matter in the Casimatter of 2.23 g/cc. The 1/3rd containing the dielectric will also contain the negative Casimir mass density of -3.0x10^{-17} g/cc, for an average density of the vacuum energy in the Casimatter of 1. 0X10^{-17} g/cc.

For an experiment, we would want to fabricate about a cubic centimeter of Casimatter, probably in the form of a plate 10 cm by 10 cm by 0.01 cm thick. Since the thickness of a layer pair is 40 nm of aluminum followed by 20 nm of dielectric, or 60 nm overall, there would be 1667 layer pairs, not that difficult to fabricate. The real question would be whether it is possible to measure a sample and its container vial massing a few grams to an accuracy of 10^{-17} g or better. Right now, I can't think of a way to do it, since the force levels are beyond the present capabilities of available atomic force microscopes and the accuracy required for a frequency measurement is beyond the capabilities of available clocks.

People thinking about working on this idea should appreciate that the energy density levels involved are smaller than chemical energies and an experiment must include accurate calorimetry. For example, since aluminum has a specific heat of about 0.9 J/K•g, in order to measure the estimated Casimir energy density of the Casimatter of -2.7 mJ/cc, a 1 cc sample would have to be temperature controlled to better than a millikelvin, and the heat flow into or out of the sample would have to be known to better than a millijoule. In fact, a useful first experiment would be to fabricate some Casimatter and measure how much it cools off as the negative Casimir energy in the Casimatter is eliminated by destroying the internal structure. This thermal-type experiment would show that the Casimir effect produces measurable negative energy, but it would not give any definitive experimental evidence for a mass modification effect.

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SHORT LIST OF ACTIVE RESEARCHERS IN VACUUM FLUCTUATIONS

Barton, Gabriel
Physics and Astronomy Division University of Sussex, Brighton BN1 9QH, England, UR G.Barton@sussex.ac.uk *Theoretical work on many aspects of vacuum fluctuation, including the problem of the superluminal speed of light between Casimir plates.*

Boyer, Timothy H.
Department of Physics The City College of the City University of New York Convent Avenue at 138th Street New York, New York 10031 USA boyer@sci.ccny.cuny.edu *Many theoretical papers on vacuum fluctuations.*

Braginsky, Vladimir B.
Moscow State University, Moscow 119899, Russia brag@mol.phys.msu.su Coauthor with F.Ya. Khalili on vacuum fluctuation "friction" and "damping." *Usually works on gravitational radiation antennas and "quantum non-demolition" measurement techniques.*

Cantatore, G.
Departimento Fisica, Univ. Trieste, I-34127 Trieste, Italy *Papers on interaction of high energy photons with a magnetic field.*

Carugno, Giovanni
Instituto Nazionale di Fisica Nucleare Sezione di Padova, 35131 Padua Italy *Paper with Roberto Onofrio on detecting casimir forces using a tunneling electromechanical transducer. Paper on interaction of high energy photons with a magnetic field.*

Cole, Daniel C.
IBM Corporation, Essex Junction, VT 05452 USA dan_cole@vnet.ibm.com *Co-author with Haisch and Rueda on cosmic void ZPF particle acceleration paper.*

Ding, Yujie (Y.J.)
Department of Physics and Astronomy Bowling Green State University 104 Overman Hall Ridge Street, Bowling Green, OH 43403 USA yding@andy.bgsu.edu *Co-author of papers on nonlinear magneto-optics of vacuum with A.E. Kaplan.*

Drever, Ron
Physics Department, California Institute of Technology Pasadena, CA 91125 USA rond@tapir.caltech.edu *Measured anisotropy of inertia to $5x10^{-23}$ in 1961 paper. Now running CalTech portion of LIGO (Laser Interferometer Gravitational Observatory).*

Eberlein, Claudia
Newnham College, Sidgewick Ave. Cambridge, CB3 9DF England, UK claudia@cromwell.physics.uiac.edu *Papers on theory of sonoluminescence being due to the Unruh effect.*

Forward, Robert L.
Forward Unlimited, P.O. Box 2783, Malibu, CA 90265 USA forward@whidbey.com *Paper on extracting electrical energy from the vacuum. Conducted contract studies of vacuum fluctuation phenomena for the U.S. Air Force and NASA/JPL.*

Haisch, Dr. Bernhard
Lockheed Solar and Astrophysics Laboratory Div. 91-30, Bldg. 252, Lockheed Palo Alto Research Lab. 3251 Hanover St., Palo Alto, CA 94304 USA haisch@sag.space.lockheed.com *Coauthor with Puthoff and Rueda on vacuum fluctuations being the source of inertial mass. High energy physicist and Associate Editor, The Astrophysical Journal.*

Hawton, Margaret
Department of Physics, Lakehead University Thunder Bay, Ontario, Canada P7B 5E1 mhawton@gale.lakeheadu.ca *Papers on source fluctuations causing effects rather than vacuum fluctuations. Doesn't believe in vacuum fluctuations.*

Hinds, E.A.
Physics Department, Yale University POB 6666, New Haven, CT 06520 USA *Paper on measurement of the Casimir-Polder force with ground state sodium atoms between plates with C.I. Sukenik, M.G. Goshier, D. Cho, and V. Sandoghdar.*

Iacopini, E.
Dipartimento di Fisica dell'Universita di Firenze Florence, Italy *Proposed experiment to use confocal mirrors as Casimir plates to measure the Casimir force at centimeter distances.*

Kaplan, Alexander A.,
Prof. Dept. Electrical and Computer Engineering, The Johns Hopkins University, 3400 N. Charles Street, Baltimore, MD 21218 USA sasha@super.ece.jhu.edu http:// psi.ece.jhu.edu/~kaplan *Co-author of papers on non-linear magneto-optics of the vacuum with Yujie Ding.*

Lamoreaux, Steve K.
Physics Department, Bldg. F-15 University of Washington, Seattle, WA 98195 USA lamore@galileo.phys.washington.edu *Faculty adviser to Dev Sen on experiment to measure the Casimir force between two gold-plated quartz flats at large distances.*

Latorre, Jose I.
Departament d'Estructura i Constituents de la Materia Facultat de Fisica, Universitat de Barcelona Diagonal 647, 08028 Barcelona, Spain latorre@ecm.ub.es *Wrote 1995 paper calculating the speed of light for a different "non-trivial vacua" with Pedro Pascual (pascual@ecm.ub.es) and Rolf Tarrach (rolf@ecm.ub.es)*

Maclay, G. Jordan
Department of Electrical Engineering and Computer Science University of Illinois at Chicago M/C 154, P.O. Box 4348, Chicago, IL 60680 USA *He and students are looking at measuring and using Casimir forces in microelectromechanical structures.*

Mead, Franklin B., Jr.
PL/RRF Air Force Phillips Laboratory, Edwards AFB, CA 93524-7680 USA *Has filed patent on extracting energy from the vacuum.*

Milonni, Peter W.
Theoretical Division, LANL, Los Alamos, NM 87545 USA pwm@t4.lanl.gov *Many papers showing that effects attributed to vacuum fluctuations can be explained by correlated quantum fluctuations of the source charges in the experimental apparatus.*

Onofrio, Roberto
Dipartimento di Fisica, Universita di Padova Via Marzolo 8, 35131 Padua Italy onofrio%38619.hepnet@csa4.LBL.gov *Paper with Giovanni Carugno on detecting Casimir forces using a tunneling electromechanical transducer. Paper with Bakalov on interaction of high energy photons with a magnetic field. Has also worked on quantum non-demolition measurement techniques.*

Puthoff, Hal E.
Institute for Advanced Studies at Austin 4030 Braker Lane W., Suite 300, Austit, TX 78759 USA puthoff@aol.com The person that started all this by saying that gravity and inertia are cased by vacuum fluctuations.

Rueda, Alfonso
Dept. Electrical Engineering, ECS-518 California State University at Long Beach 1250 Bellflower Blvd, Long Beach, CA 90840-8303 arueda@csulb.edu *Many papers on vacuum fluctuations. Co-author with Puthoff and Haisch on vacuum fluctuations being the source of inertial mass.*

Scharnhorst, Klaus
Department of Physics, University of Wales Swansea Singleton Park, Swansea SA2 8PP, Wales, UR R.Scharnhorst@swansea.ac.uk *Theorist, discovered the Scharnhorst effect, that the speed of light is greater than c perpendicular to Casimir plates.*

Schwartz, Alan M.
(Uncle A1) Chief Technical Officer, Molecular Genesis Life Sciences LTD, Vancouver, BC, Canada Snailmail Address: 49 Fabriano, Irvine, CA 92720-2525 USA unclealO@ix.netcom.com ("zero" before @) http://vvv.com/ adsint/freehand/uncleal/ *Suggested making and weighing "Casimatter". Only publications on Casimatter to date are on e-mail from Schwartz and in this report.*

Sen, Dev
Honors Undergraduate Student Physics Department, Univ. Washington, Seattle, WA 98195 USA Home: 1304 NE 42nd Ave. #209, Seattle, WA 98105 USA dsen@u.washington.edu *Carrying out experiment on Casimir plates made of gold-plated quartz flats, trying to measure Casimir force at large distances.*

Tarrach, Rolf
Departament d'Estructura i Constituents de la Materia Facultat de Ffsica, Universitat de Barcelona Diagonal 647, 08028 Barcelona, Spain rolf@ecm.ub.es *Wrote 1995 paper calculating the speed of light for a number of different "non-trivial vacua" with Pedro Pascual (pascual@ecm.ub.es) and Jose Latorre (latorreEecm.ub.es)*

Widom, Allen
Physics Department, Northeastern University, Boston, MA 02115 USA widom@neu.edu *Papers on microchips and vacuum radiation from moving conductors.*

We Want Photos of License Plates with Cold Fusion and New Energy Themes!—EFM

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Book Review... *THE REVOLUTION IS COMING!*

The Coming Energy Revolution by Jeane Manning

(Freelance journalist), 1996, published by Avery Publishing Group, Garden City Park, New York, 230 pages, illus., resource list, glossary, indexed, ISBN 0-89529-713-2.

Reviewed by Hal Fox, (Review reprinted from *New Energy News*, July 1996, Fusion Information Center, P.O. Box 58639, Salt Lake City, UT 84158-8639)

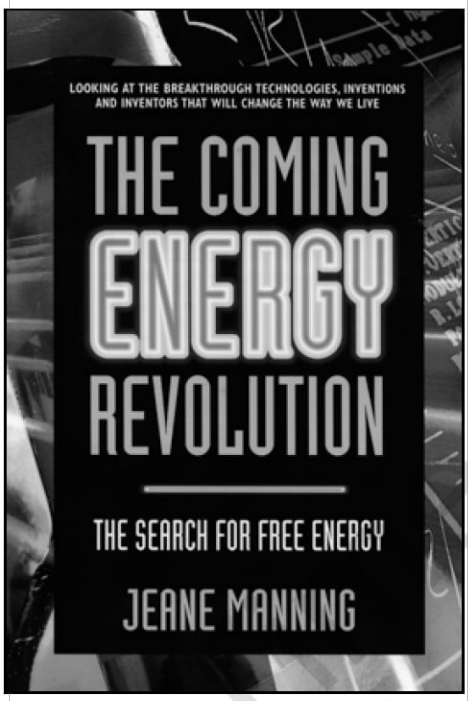
This timely book is highly recommended for all readers, especially for the general reader. It provides both an excellent report on the historical background of the search for new energy and introduces the readers to those who are now involved in various aspects of new energy developments.

The book is divided into four parts: Part I - Past Revolutionaries; Part II - Space Energy and the New Physics; Part III - Emerging Energy Technologies; and Part IV - The Energy Revolution -- Potential Amid the Problems. In addition, the book begins with a favorable Foreword by Brian O'Leary, who is well known in the new-energy field.

Part I discusses some of the historic work of Nikola Tesla, John Ernst Worrell Keely, Walter Russell, Thomas Henry Moray, Lester Hendershot, Viktor Schauberger, and Wilhelm Reich.

Part II tells us about some of today's geniuses such as Moray King, Harold Puthoff, and Thomas Bearden and their efforts to help provide a scientific underpinning for "space energy." Next, the works of Kenneth Shoulders and his high-density charge clusters, Wingate Lambertson and his cermet devices, and John Hutchison and his new rock-crystal devices. These three innovators are apparently tapping space energy with three different solid-state devices. The work of the late Floyd "Sparky" Sweet is described. Four other persons who have worked with rotating machines in the production of energy are introduced: Bruce dePalma (now of New Zealand), Bertil Werjefelt (Hawaii), Shiuji Inomata (Japan), and Paramahamsa Tewari (India). These are four of the leading lights in the development of the "N-Machine," which was instigated by Bruce dePalma.

Part III discusses the advent of cold nuclear fusion, first announced in 1989 by Professors Stanley Pons and Martin Fleischmann at a press conference called by the staff of the University of Utah. The author cites that the work not only is continuing but is being commercialized. The work of the late Francisco Pacheco in producing hydrogen gas from sea water and using this power for a variety of energy devices is presented. In a similar task to develop the power of hydrogen, Jeane Manning brings us up to date with the life's work of Roger Billings (formerly from Utah



and now in Independence, Missouri).

Part III also includes the stories behind the work of Peter Lindemann and George Wiseman in using relatively low-grade heat as a useful power source. Their efforts to develop Low-Temperature Phase Change (LTPC) technologies are discussed. Also, Jeane tells us the story of Harold Aspden (one of our active correspondents) and his search for better ways of using magnets and heat to produce useable energy. This part of the book includes a report on William Baumgartiner who is improving on the work of the late Viktor Schauberger in the use of vortexing water. The trials and tribulations of the use of the new technology of low-flow water power, as developed by Martin Burger, is included in this part of Manning's book. Finally, the work of Johann Grander (another follower of Viktor Schauberger's work) and his discovery of "living water," the rotating energy-producing disks of Paul Baumann at the Methernitha commune, and the Hydrosonic Pump of James Griggs, are discussed. These are fascinating tales of the difficulties of getting (or not allowing) new-energy developments to get to the market place.

Part IV of this easy-to-read book consists of three chapters entitled, "Harassing the Energy Innovators," "Society and a New-Energy Economy," and "The Power is in our Hands." This finale of an excellent book discusses the problems, the solutions, the challenges, and the opportunities that we all face in the development, acceptance, marketing, and enjoyment of the new energy devices.

The reader of this book will find that we still have things to learn from early new-energy developers who devoted their lives to their work. Of great importance is the fact that there are a number of living researchers who are likely to become well known as the inventors and developers of viable new energy technologies. In this reviewer's opinion, some of the products mentioned in the book will not become commercialized because the technology is maturing so rapidly that a better product may be on the market before an existing product can be commercialized. For example, it is this reviewer's judgement that the N-Machines will be replaced by such developments as the Takahashi super magnet, super motor. Some of the solid-state devices may never make it to market because there are newer and better devices that are emerging from laboratories. The past, present, and future development of new-energy devices that will change the world from a fossil-fuel economy to a space-energy economy makes an exciting story. All three classes of events are treated in this excellent book by Jeane Manning. We recommend this book to you.

In a personal note, as the author of *Space Energy Impact in the 21st Century*, I am indebted to Jeane **because this book of hers is an excellent introduction to my own forthcoming book** (scheduled for July, 1996). From the vantage point of being the editor of two newsletters and having the privilege of becoming personally acquainted with some of the world's leading workers in the new energy field, my book will reflect some of the latest materials that can be published about several new devices that are tapping space energy. Therefore, from a selfish point of view, thanks Jeane Manning for an excellent introduction to space energy! —*Hal Fox*

EDITOR's Note: This busy editor is delighted to be able to rely on Hal Fox for this fine book review, but in a future issue of *Infinite Energy*, I will add my own personal reflections on Jeane's book. ***—Gene Mallove***

Do it—please!

Write a letter about cold fusion and new energy to your Congressman, Senator, President, favorite Presidential Candidate, or Prime Minister.

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Reinventing the World: Social and Economic Effects of Cold Fusion

by Charles Barr

Twenty years ago, when personal computing was in its infancy, few people imagined the extent to which it would transform the world. Who could have predicted desktop publishing or multimedia or the Internet in 1976? The cutting edge of technology always leads down novel and unexpected paths, which appear obvious only in hindsight.

It is equally impossible to predict, in 1996, how the world will look a mere 20 years from now as a result of cold fusion technology. What is certain is that the impact will be immense. When examining the obvious and immediate consequences - plentiful and inexpensive energy, accompanied by a massive reduction in pollution - it is easy to overlook many of the more profound social, economic and political upheavals that are bound to follow. However, without predicting precisely when or how these upheavals will occur, we can anticipate many of the revolutionary changes that will transform the world forever as cold fusion technology takes hold. This article will discuss a few of the more significant likely consequences.

1. *The price of nearly everything will tumble.* A sharp drop in consumer energy prices will be only the beginning. Everything — from homes to automobiles to food to precious metals to toys — will be impacted. A great deal of the cost of any product depends upon the cost of the energy needed to produce it. Lowering the energy cost of production will lower the cost of the product.

As an example, let's take a closer look at the potential impact of cold fusion on the automobile, which is a major expense for most families. The cost of fuel will drop to nearly zero; but what about the price of a new car? The availability of inexpensive cold fusion energy will dramatically lower the cost of making one. Extracting, refining and transporting raw materials (such as steel) will become much less expensive, so their prices will drop. The cost of the energy needed to run the auto plant itself will likewise tumble. Cheap energy will boost the competitive advantage of factory automation, by lowering the cost of the energy needed to run automated equipment; therefore, fewer workers will be needed, and labor costs will shrink. Of course, there will also be savings in the cost of transporting the car to the dealer. And whatever its final form turns out to be, the car's cold fusion engine will certainly be simpler and less costly to maintain than the horribly complex internal combustion engine and its anti-pollution devices. In short, as lower energy prices are felt along the entire production chain, manufacturing costs will plummet; and the discipline of global competition will insure that these savings are reflected in the final price of the car.

A similar case can be made for the impact of cold fusion technology on the prices of most other goods. Food prices will drop as the cost of irrigation, planting and harvesting falls. Marginal land will become profitable to farm, and will be put into production. Gold and silver prices will fall as the energy costs involved in exploration and mining become insignificant, leading to much greater mining activity and an increased supply. (The transmutation of elements in cold fusion processes could further add to this supply.) For almost any product you can name, cold fusion will mean good news for the consumer.

2. *Cold fusion will remake the political map of the world.* The Middle East will lose much of its political and economic clout as oil prices collapse. However, cold fusion technology will make it possible to expand farming there, and create self-sufficiency in other ways. Japan, which currently relies heavily on imports of oil and other energy resources, will achieve energy independence and become an even stronger economic powerhouse. (This may explain the Japanese government's eagerness to fund cold fusion research.) The ailing economies of Russia and the rest of the former Soviet Union will especially benefit from cold fusion, enhancing their ability to exploit their rich natural resources, rebuild industrial and transportation infrastructure, and create a higher standard of living. By mitigating economic hardship, cold fusion will play a major role in restoring political stability to Russia and making the country less likely to revert to an anti-western dictatorship.

3. *Cheap land will become more expensive, and expensive land will become cheaper.* The quantity of land in the world is fixed, so cold fusion will impact land prices differently from the price of other goods. Most of us are familiar with the three most important factors in determining the value of a piece of real estate: "location, location and location." This is the reason that an acre of land in downtown Tokyo is worth tens of thousands of times as much as an acre in the middle of an unpopulated desert. People are willing to pay more for land that comes with advantages such as ease of communication, accessibility, proximity to transportation and availability of power sources.

The first of these factors, ease of communication, is rapidly becoming available in every location in the world, courtesy of technological advances such as global electronic mail and inexpensive worldwide satellite transmission. Cold fusion technology will assist in spreading the other three advantages to every point on the globe. Remote areas will become much less remote (and consequently more desirable economically). Inexpensive long-range transportation, powered by cold fusion, will make it practical to initiate commercial activities, such as mining and manufacturing, in places where it previously would not have been cost-effective. The portability of cold fusion generators, along with their ability to produce large amounts of continuous "free" energy, will mean that availability of nearby external power sources (such as hydroelectric or coal) will no longer be significant in determining the desirability of a piece of land.

Other factors (such as the proximity of suppliers, and cultural amenities) will continue to make land in urban centers more valuable than land in less developed areas. But over time, as "remote" areas are developed, the variation in value will become much less extreme.

4. *The volume of world trade will decrease.* A paradoxical effect of cold fusion is that it will lower the cost of world trade at the same time as it reduces the need for it. While the cost of manufacturing and shipping trade goods will be slashed, the price differential between domestic and imported products will also be slashed, in some cases disappearing altogether.

International trade depends upon countries importing products that they can buy more cheaply than they can make domestically, while exporting products that they can make more cheaply than other countries can. Cold fusion will be a great equalizer; the drop in energy and other costs will allow many items to be produced locally that would previously have been imported. The impacts will be uneven: Trade in conventional energy sources, such as oil, will be decimated; trade in manufactured goods will be reduced, as local producers provide more competition; but tourism will increase substantially, as travel becomes much more affordable.

5. *The workplace revolution will accelerate, and the average work week will*

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shrink. Current technology is already fueling an increase in the demand for "mind workers" while reducing the need for less-skilled labor. Cold fusion technology, by reducing the cost of automation, will speed up this trend. Blue-collar jobs will continue to be lost in the manufacturing sector, but that loss will be offset by additional jobs in the technology, service and entertainment sectors. This trend is already well under way, and the massive unemployment that many feared would accompany this workplace transition has not materialized.

The lower price levels brought about by cold fusion will create a "wealth effect," in which each dollar a person has or earns will become more valuable. This effect will be the same as if prices remained steady and everyone were given more money. Cold fusion will thus reverse the trend of the past few decades, which has seen a steady decline in the average worker's purchasing power (partly due to rising energy costs, and partly due to rising taxes and inflation). The "wealth effect" of lower prices will permit many people to switch from full-time to part-time work without sacrificing their standard of living, much as the industrial revolution ultimately replaced dawn-to-dusk, seven-day-a-week farm chores with the 40-hour work week. It will also spark an increase in the number of single-earner families, allowing more parents to stay at home while their children are young.

We can look forward to many more dramatic changes as cold fusion technology becomes a commercial reality. Inexpensive transportation and an explosion of available leisure time will precipitate radical changes in the average person's lifestyle. Many large centralized institutions will become obsolete, electric utilities being the most obvious example. The cost of government services will go down, as will the demand for them. Cold fusion will interact with other leading-edge advances in science to accelerate the speed of technological change. (Examples: self-powered robots, medical devices, and space vehicles.)

Most of us hope to someday achieve a society in which war and hunger are a distant memory. By replacing scarcity with abundance, cold fusion technology may be the vehicle that makes this optimistic scenario a reality.

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EMPOWERMENT[1]
The Life Force of the Energy Revolution

By Mike Fisher, Director of Zenergy Corporation

Introduction

This is the first in a series of articles about the embryonic industry of Space Energy. Future articles will expand on many of the concepts introduced here. This series has been prompted by our experience of some of the problems facing this industry and I humbly offer what I can, with the purpose of seeing this industry flourish I see many people in this field battered by unfulfilled dreams, dashed hopes, often impoverished, having devoted all to their research, and having received little recognition let alone financial reward for their efforts. I sense many are disempowered, not knowing how to move forward, seemingly with the whole world against them, whether it be the bank manager, the family, greedy big business, the government, academia, the military, etc.

This article is therefore about ***empowerment,*** not only of ourselves individually but also our organizations, our businesses, channels of communication, and dare I say it, the hardware itself. Where are the machines that are going to power the next century and beyond without fuel and without pollution?

I have been involved with new energy for about four years, a relative newcomer compared to many. However, prior to that I was working with other renewable energy technologies and strategies for implementation and was dealing on an international level reviewing national and continental strategies for the future of energy well into the next century. The question that guided me was: "Given that much of our current methods of production and use of energy are unsustainable, what has to happen if we are going to make the transition to a sustainable future?" The question about sustainability is: "What are my actions today (and those of my company, community, or nation) and do they in any way deny or adversely affect the ability of future generations to sustain life or enjoy the quality of life that I enjoy today?" In answering each of those questions positive action was required.

I asked myself those questions so that I could answer far deeper ones, and they may apply to you too: "Am I just a victim of circumstance, a small nobody without a voice, unable to determine my own destiny, or could it be that there are solutions and that there is hope and purpose, and maybe I have a part to play in those solutions? Why was I born at this time in history with these particular talents? What specifically is the life I choose for myself today?"

Before I had even heard of space energy, I discovered that the entire world's energy needs could be met by photovoltaic cells ***covering only 4% of the world's deserts***, and Sanyo, the visionary Japanese company, have set their sights on manufacturing in large enough quantities and at a competitive price to do just that by 2030. There is enough energy in the River Inga in Zaire to power half of Africa. There is enough wind energy potential on the west coast of Ireland alone to power all of Europe. There is enough wind energy potential in the midwest of the USA to meet a substantial part of the US power demand. Recent advances in variable speed generators have made wind energy more than competitive with nuclear energy—beating coal powered energy in some places. Technological breakthroughs in photovoltaics could result in PV's being available at one tenth of their current price within 5 to 10 years and competitive with large scale thermal power plants. That's not to mention fuel cells, geothermal, tidal, solar thermal, or even space energy. There are solutions but none of the traditional "renewables" offer mobile on-demand power day or night except space energy. As a result, most of the new energy production capacity is still polluting. To change that is our challenge.

Our beliefs shape our experience of life

It has often been said that our beliefs determine our destiny and the quality of our lives; what's more in this increasingly complex world, it is possible to find plenty of evidence to support or invalidate a belief either way. Each of us needs to ask ourselves which beliefs stand up to scrutiny, will empower us and help us to lead productive, worthwhile, and ultimately happy lives. It is our choice.

Below are a few "beliefs" that are prevalent in this industry. They are listed as a challenge. They may or may not be true for us, and if so do they serve us? When we read them and the following notes, what feelings do they evoke in us? If we search deep inside, we might feel negative emotions of anger, fear, sadness, resentment, despair, or irrelevance, and there we may find the key to our own empowerment.

Belief No 1. "There is not enough to go round. You have to fight to survive in this dog-eat-dog world. Life is such a

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struggle."

Mahatma Gandhi once said, "There is enough for everyone's needs, but enough for no one's greed." Does each of us have air to breath, clothes to keep us warm, food to eat, water to drink, shelter and a friend in the world to comfort us? Do we know the difference between what we need and what we want? We might be surprised to find we need much less than we think. Sure there are a lot of greedy people in the world and it's easy to blame them for our situation, however there is nothing wrong with desires over and above our needs, provided that we also have the ability to release attachment to any particular outcome. The sources of misery in this world are generally rooted in (a) cravings and desires for certain things or outcomes, and the disappointment of unfulfilled dreams, and (b) aversion to things and events we don't want to happen to us, and the pain we feel when they do. How much is our own greed the source of scarcity in our lives and therefore our unhappiness?

Belief No 2. "There is a plot to discredit my ideas. The academic and professional establishment is against me."

We have all heard stories of conspiracy and also of professors and professional engineers refusing to acknowledge an over-unity result. I have not personally tested the Patterson Power Cell or Paulo and Alexandra Correa's invention, so I cannot comment on them, but we have investigated or tested possibly upwards of 100 different technologies and I have found not even one that I can honestly say has tested over-unity. Not one! Having said that, I have invested my own money in new energy technologies and am in this business to commercially develop working technologies successfully. Nothing would please me more than to find just one with some commercial potential.

There is no better way to quiet the critics than by irrefutable results and repeatable experimental technique.

Many have entered this field and invested in technologies that do not work. The reasons for these technologies not working include over zealous expectations, flawed testing methods and measurements, difficulties in repeatability and unfortunately, a few rare cases of outright fraud. No investor will put up large amounts of money unless the device has been tested independently of the inventor. In our experience, good experimental technique is the rare exception rather than the norm. In addition, many inventors believe that established science has "got it all wrong," and yet the very same inventor may lack the understanding and knowledge to communicate to the academic how the traditional understanding is flawed. The academic loses patience and the inventor reinforces his own belief that he is the victim of an academic conspiracy.

To overcome this polarization, we need to communicate and build strategic alliances with professional engineers or scientists whom we can trust. Explain the technology (under a confidentiality agreement, of course), help them understand and become our advocate. A good professor could be worth his weight in gold, as they know the ropes when it comes to raising research funding. With a working technology, the inventor needs to find the right backer for help with the components of the commercial "package" in order to raise the necessary capital for full product development. We will be addressing how to do this in later articles.

Most human failures in the management of businesses occur because people either do not know what to do, or they do not know how to do it. We need to know our strengths and weaknesses, and find the right team to support us in areas where our expertise is lacking, both in terms of what to do and how to do it. This may apply to testing, business planning, corporate structures, patent protection, etc. We do not have to do it all on our own, and we will be much more successful with a good team.

Belief No 3. "The vested interests, oil companies, utilities, and car manufacturers only want to steal my idea and suppress it along with all other free energy technologies."

There is no doubt that some vested interests will go to great lengths to protect themselves and their long term investments. However, there is another side of the coin, which is far more significant. There are huge untapped energy markets around the world. In Asia the national economies are growing so fast that they will buy whatever technology they can. They are not the pawns of the oil cartels. The economic growth of many countries is limited by how quickly they can build power stations.

Japan imports most of its energy and is spending hundreds of millions of dollars annually to find clean alternatives and is making great strides forward in cold fusion.

Epidemiological studies show that respiratory diseases rank very highly as major health problems in countries such as China, India, Mexico and Thailand, where air quality is very poor due to burning of fossil fuels and low or unenforced emissions standards. They are desperate for alternatives.

Belief No 4. "The vested interests, oil companies, utilities, and car manufacturers only want to steal my idea and make billions at my expense."

Well, make up your mind. Which is it, 3 or 4? Carefully planned licensing can result in license fees and substantial ongoing royalties flowing to the inventor without having to sell out. Many inventors make the mistake of revealing or publishing their technology before it is properly protected, and, in effect, deny themselves the opportunity of ever being able to patent it. If you have a technology, we strongly recommend that you keep it highly confidential until you have seen a patent attorney and found a team that you can trust to commercialize the technology. The whole issue of intellectual property protection and strategy is a complex one and will be the subject of a further article.

Once the technology is adequately protected and a strategy in place to ensure that the technology cannot be suppressed or shelved, it is our opinion that as a longer term strategy it could be far more profitable (and also ensure achievement of environmental and humanitarian objectives) to include potential competitors and make them partners in certain ventures or niche markets. Turn the enemy into an ally. If they are going to otherwise lose market share to new technology, it is good strategy for them to participate in the profitable exploitation of that new technology.

Belief No 5. "The government is not interested in clean energy and wants to maintain the status quo."

Governments around the world are cumbersome bureaucracies operating under rules and procedures. Some have excellent programs for technology advancement. It is all too easy to give up with governments too early. It takes skill and determination to find the right people and programs in the right governments to give us what we need. All too often a less than enthusiastic response from a disinterested bureaucrat or busy politician results in reinforcing a belief in suppression or conspiracy.

Don't waste time fighting an uphill battle There are plenty of governments and programs that will support us.

The US government has allocated several hundred million dollars to the US Auto Battery Consortium to develop an electric car. Although production models are slow to roll off the line, GM launched the Impact battery car in August 1996. Until the batteries are charged from renewable sources, the pollution is being transferred from the tail pipe to the power station. However, at least it is a start for the market penetration of a zero emissions vehicle.

Vice President Al Gore, in his excellent book, *Earth in the Balance*, is well informed and deeply concerned about the environment and particularly energy. [*Editor's note: On the other hand, Mr. Gore has deliberately refused a briefing on the subject of cold fusion. In the matter of cold fusion, he follows political expediency and pack mentality, not truth.—EFM*] The first half of the book deals predominantly with climate change, demonstrating that disruptions in the climate pose the most serious threat to life on earth, and that humanity is headed down a path of self destruction unless some radical changes are made. He further lays out an environmental "Marshall Plan" about how to transition to a vibrant sustainable economy.

In 1973 at the time of the first oil crisis, the US imported 25% of its oil, now that figure is 50%. The government is concerned about its trade deficit, and yet continues to fund the protection of Middle East oil supplies through military means. The US Department of Energy and its programs for new energy technology have come under extreme scrutiny from Congress, and many programs have been cut. [*Editor's note: As well they should be!—EFM*]

However, in Europe, global warming is regarded as a major threat to the survival of humanity, and hundreds of millions of dollars are available in EC grants for technologies that reduce CO_2 emissions. One target is to have 10% of Europe's electricity generated from wind by the year 2005. In Brazil, a major program has been in place for some years for vehicles powered by fuel from sugar cane. Over the last few years, Zenergy has nurtured senior government and industry contacts in Asia who are very interested in new energy technologies and have billion dollar funds available to develop them.

As you can see, it is a mixed bag of good and bad.

Belief No 6. "The Patent Office will not grant patents for over-unity machines, because in their stupidity they believe that 'over-unity is perpetual motion and that's impossible, isn't it?"

We at Zenergy have on file at least 10 granted patents for "high efficiency" devices, mostly motors and generators. These devices have all been patented by the inventors with over-unity in mind. One of the most recent and exciting patents issued was for the Patterson Power Cell. Most of us believe that the essence of the "free" energy and cold fusion technologies lies in the tapping or conversion of the "aether" or "zero point energy" field. So why try and disprove the Law of Conservation of Energy? Until it is unequivocally disproved, we should use it and write the patent applications appropriately—in such a way that a patent

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will be granted, without the examiners having to rewrite the laws of physics?

Fear: the slow slayer of the human spirit

Fear is an excellent tool for mind control and for destroying the human spirit. Fear is the terrorist's prime weapon. Oppressive regimes have used it throughout history, e.g. in Nazi Germany, South Africa, and the USSR. The cold war was fuelled on both sides by fear of the other, with neither side wanting to go to war.

In this industry fear is preventing the completion of some very promising technologies, or if they are completed, it is preventing their commercialization. First, the fear of suppression or the "men in dark suits" has driven many to a state of paranoia. The six beliefs above will not be shaken, and these are unconsciously sabotaging success. Somehow a prototype is never actually finished and many investors have been maligned for giving up on inventors, when all the investor sees is his money flowing out with no results. I know of several claimed over-unity devices that have been destroyed by their inventors—one because the inventor feared that someone would steal the technology, and another because he had received threats. Some of these fears are very real and I am sure that some people have been threatened, but I sense an industry-wide paranoia fuelled by a few unpleasant and isolated incidents.

So long as fear remains as a dominant element of our consciousness we can never be free, and we will never reach our full potential. We will become slaves to that fear and we will never see space energy.

Empowerment, Freedom and Creation

The fundamental key in this industry lies in the unique nature of the technologies. For the first time in human evolution (as far as we know from recorded history), here are technologies that tap into the unlimited abundance of the universe— space energy. It may allow a whole civilization that is now based on limited resources, fierce competition, equally fiercely guarded interests, and polluting practices, to become obsolete and transcend to a new consciousness. If one of these inventions, instead of being a fuel-less generator, was for instance a new "widget" that had the potential to make billions of dollars profit, it would be nothing in the evolutionary scale compared to a space energy technology—one that demonstrated a fundamental universal law, the law of abundance and of unlimited supply. Energy is the very essence of creation.

This goes beyond a physical product, beyond a business venture, and beyond the realms of each of our life's purpose, and gives us the opportunity to humbly serve a higher force—the opportunity to change the course not only of human but of the planet's evolution. This is bigger than any of us as individuals, given to us by some "grace" beyond our understanding.

Success can only be achieved if we are very clear about our vision and how in practical terms we manage to hold and implement that vision, whilst at the same time ensuring a profitable outcome. Achieving that balance hangs on the distinction between two polarities: creativity versus competition.

• Creativity is based on the belief in abundance, the endless stream of new and free ideas.
• Competition is based on the fear of scarcity, and therefore has to fight to survive.
• Creativity flows from the purpose motive rather than the profit motive.
• Greed clings, gratitude gives. Focusing on gratitude raises the spirit, lifting the individual out of the heaviness and pressure of competition and turning them towards a creative frame of mind. Gratitude affirms abundance.
• The future of humanity depends on how well we learn to cooperate rather than compete or fight each other. Cooperation must start with each of us personally.
• A person who is restricted, drained, frightened, punished, controlled and taking is generally a person with less life, health, happiness and love and is on the competitive level.
• A person who is released, energized, enlightened, free, and giving is generally a person with more life, health, happiness and love and is on the creative level. Competition takes, and creation gives.

Fear is that insidious poison squeezing the life force from our very souls. The opposite of fear can be expressed in terms of love, freedom and peace. To make this more meaningful, we might take a few moments and quietly reflect on how much love we individually have for ourselves. Do I honour and nurture my body, mind, and spirit? How free am I in my thoughts and in my life? Am I a slave to my fears or the master of my destiny? Am I at peace with myself in my heart?

We might ask ourselves how much love, freedom and peace we have in the other major relationships in our lives, for instance our relationship with our families, our friends, and workmates, the relationship with our community, our relationship with nature and our environment, our nation, other nations, and our creator.

In conclusion, times have changed. The oppression of the past is giving way to an acceptance of new ideas and technologies to heal the planet. We at Zenergy have had no opposition in our marketing efforts of space energy technologies, in fact quite the opposite. The markets are there; the money is there. All that is lacking is a working space energy technology that can be developed into a product.

Now is the time to take courage, put aside our fears and take charge of our own destinies. The parable of the talents expresses this very well (Matthew 25, vs14-30). Whatever our religious beliefs, most would agree that the Bible contains words of great wisdom, and the point about abundance is made well in this story: A man went travelling in a distant land, and prior to his departure entrusted his property to his servants— five talents to one servant, two to another, and one talent to a third, to each according to his ability. When the man returned after a long time the first servant had doubled his money and gave back ten talents. The second servant likewise gave back four talents. The master was pleased with the first two and entrusted greater things to them. The third servant was afraid and had buried his one talent, and returned the one talent to his master. The man was angry at the servant's laziness and wickedness, and cast him out. "For unto every one that hath shall be given and he shall have abundance: but from he that hath not shall be taken away, even that he hath."

This is not the time to bury our talents. There is no time to lose; the earth will survive, humanity may not.

"Bold men prefer the boisterous oceans of freedom rather than the calm backwaters of despotism"

Zenergy Corporation was founded to commercially develop a range of revolutionary energy technologies, and achieve a most rapid market penetration throughout the world, with the aim of providing a foundation for the peace, health, and prosperity of all people, and for a sustainable world that supports all life.

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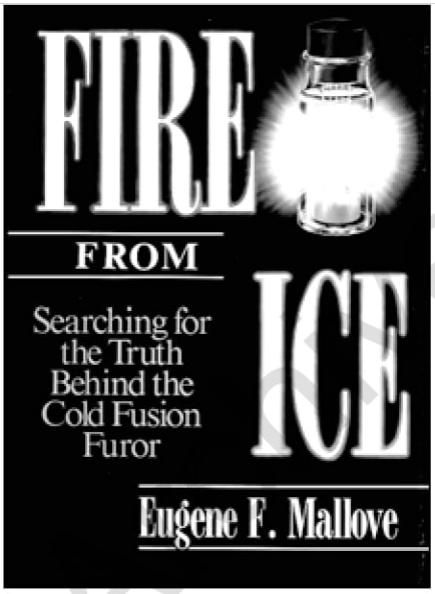

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Dr. Peter Graneau
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TAPE#2

Buford ("Ray") Conley
(MIT, graduate student, Dept. of Aero/Astro Eng.)
"Light Water Excess Heat Experiments"
Fred Jaeger
(ENECO, Salt Lake City)
"Patents and Commercialization"
Professor Peter L. Hagelstein
(MIT Dept. of Electrical Engineering and Computer Science) "Cold Fusion: What We Know and What We Don't Know"

TAPE#3

Professor Peter Hagelstein
(CONTINUED from TAPE #2)
"Cold Fusion: What We Know and What We Don't Know"
Professor Keith Johnson
(MIT Dept. of Materials Science and Engineering)
"Progress in the Theory of Excess Heat" *and Excess Heat*- The Movie, now being made by Hollywood!
James L. Griggs
(Hydro Dynamics, Inc., Rome, Georgia, USA)
"The Hydrosonic Pump: Excess Power and Other Effects"

TAPE#4

Bertil Werjefelt
(PolyTech(USA), Hawaii)
"Energy from Magnetic Materials and Magnetic Fields"
Dr. Eugene F. Mallove
(Cold Fusion Technology, Concord, NH)
Concluding Remarks

The tapes include the speakers' presentations as well as question and answer sessions. There is footage of the Hydrosonic Pump under test as well as close-up footage of rotor surface melting effects. Bertil Werjefelt shows footage of experiments in his own laboratory. There are scenes of Japanese researchers from Sumitomo, Hitachi, and other companies and universities now involved in their claimed extraction of energy from magnetic materials. These efforts are now said by these researchers to be proceeding toward commercialization. Actual experiments are seen in progress. The tapes are VHS cassettes in NTSC format and range from 120 to 127 minutes each.

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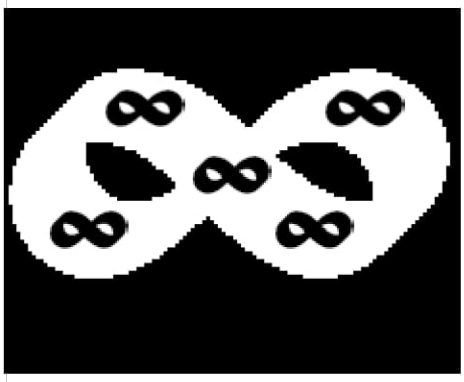

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Cold Fusion and New Energy Technology

(ISSN 1081-6372)

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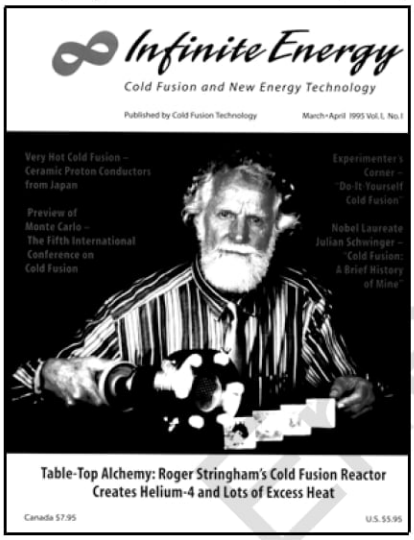

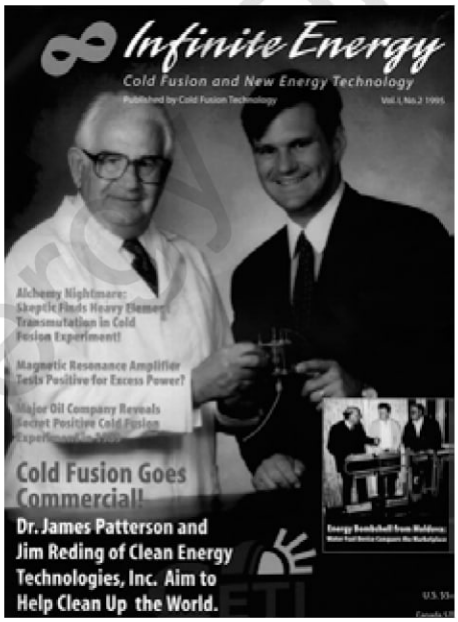

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